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ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

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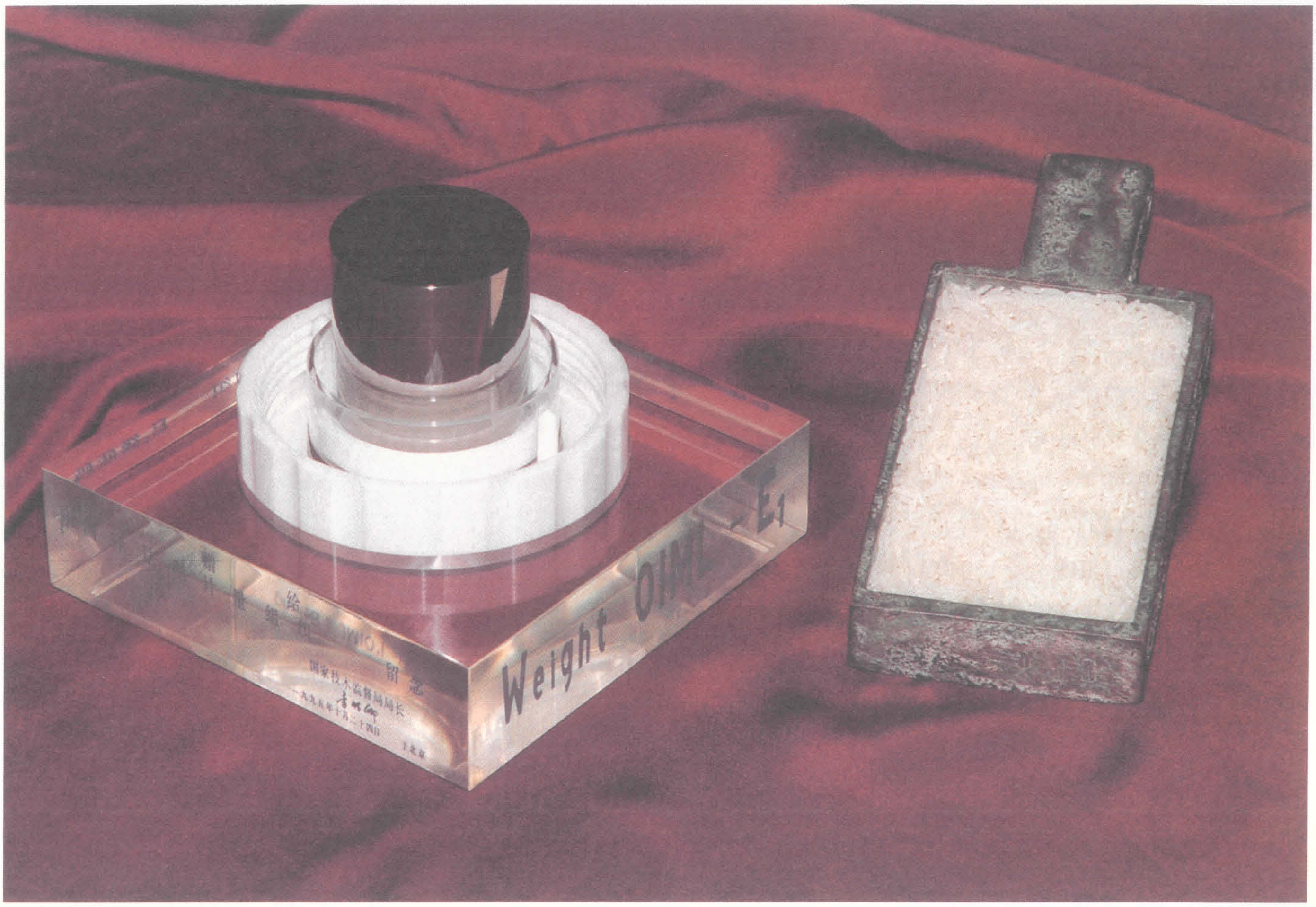

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Twenty-four centuries of metrology in China

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update

A CHINESE STANDARD CAPACITY MEASURE DATING BACK TO 344 B.C., WITH AN E_1 WEIGHT MANUFACTURED BY THE CHINESE NATIONAL INSTITUTE OF METROLOGY IN 1995.

The E_1 weight was presented to OIML on the occasion of its 30th CIML meeting in Beijing, 25–27 Oct. 1995.

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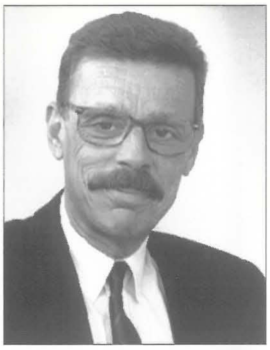

Editorial

Metrology and the 21st century

1996 will certainly be the start of a very exciting period for metrologists. Following a proposal from the French Government, which is trustee for the two Conventions governing intergovernmental metrology bodies, the *Convention du Mètre* and the *Convention establishing the Organisation Internationale de Métrologie Légale,* both the *Conférence Générale des Poids et Mesures* and the *Comité International de Métrologie Légale* have adopted very similar resolutions: they recognize that discussions should start concerning a rapprochement between the two organizations, with a view to a possible fusion, and request the Presidents of the two International Committees (i.e. Dr D. Kind for CIPM and myself for CIML) to appoint a joint working party to discuss the matter.

The first meeting of the joint working party will take place in Paris in February 1996, as a conclusion of the meetings of the CIPM Bureau and OIML Presidential Council. That is the only fact I may announce with certainty, and I must admit that nobody may predict what will be the outcome of these discussions.

Merging two intergovernmental bodies is, by itself, a long and difficult task: it involves the agreement of governments and parliaments in all countries involved. It cannot be envisaged unless there is an obvious advantage to doing so. But what kind of advantage?

In the case of BIPM and OIML, because of wide differences in their goals and activities (a scientific laboratory, for the first one, and a standardizing body, for the second one), financial and staff savings would not be more than very modest.

However, establishing a single intergovernmental body responsible for the main scientific, legal and practical aspects of metrology would be a significant step for permitting international metrology to successfully enter the 21st century.

But this is more than simply putting BIPM and OIML together in the same place. This is more than adding one and one, to get two.

This is evaluating the metrological needs of our tomorrow's world, taking into consideration the rapid changes and developments in sciences and technology, consumer protection, accreditation and certification, agriculture, health, environmental protection, etc.

This is evaluating the relevant activities of numerous international and regional organizations that have metrology-related activities, including the nearly established FICOM, Forum for Inter-organizational Cooperation in Metrology, which is intended to succeed ISO/TAG 4 *(see pp. 56–57).*

This is making use of the synergy that exists between BIPM and OIML to create the new worldwide metrology body that will lead to satisfying the needs of all those who, in their everyday activities, cannot do without metrology.

Supported by the very constructive and open discussion we had during the 30th CIML meeting, it is with this in mind that I will participate in the discussions with our colleagues of the *Convention du Mètre* with the conviction that together, we may successfully work during the next five years so as to cross the threshold of the next century. ■

G. J. Faber
CIML President

MEDICAL MEASURING INSTRUMENTS: METROLOGY AND ERGOMETRY

Dynamic test rig for medical foot crank ergometers

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1 Introduction

Medical foot crank ergometers are used to put physical stress on patients by submitting them to a well-defined effort test for the diagnosis and therapy of circulatory diseases.

After setting up the ergometer to the required load — expressed as mechanical power — the ergometer maintains that load at the selected value over a wide range of foot crank speeds. In order to take up constant power, the braking torque at the crank shaft is inverse to the speed of the cranking activity.

When ergometers are used for diagnostic purposes, there are high demands on the accuracy of the power absorbed. In rehabilitation use, the prevention of overload is absolutely essential. Sudden changes in the breaking torque must be avoided to prevent physical injury to the patient, especially after surgical treatment.

2 Foot crank ergometer testing in the PTB

Requirements for medical foot crank ergometers are established in the Verification Ordinance Appendix 15, Annex 12, Clause 5 (EO 15.12-5) [1]. The PTB checks ergometer prototypes for their compliance with the requirements and in particular, the correct breaking power. This has been carried out since 1988 using conventional instrumentation for the mechanical power measurement and a computer for data acquisition. The ergometer is driven at a number of representative speed values by an electric servodrive which simulates the foot cranking action. At every speed the ergometer is set to several power values. Figure 1 shows the range of power and speed settings.

Ergometer manufacturers tend to counteract the mechanical imperfections of their products with software methods for error compensation. This causes irregular error behavior and requires the ergometer to be measured at nearly 50 speed-power pairs within the working range shown in Fig. 1. The complete check must be repeated under different conditions, whereby the load history of the ergometer is of particular importance.

At every measurement point, the working speed is manually set at the drive controller and typed into the computer terminal. During the measurements the operator must readjust the speed to its set-point. The torque fed into the crank shaft is measured by a torque transducer connected to an A/D converter in the computer. The mechanical power is calculated as the product of speed and torque. This value is compared with the power set-point chosen on the ergometer's control panel. The maximum permissible error is 5 % or 3 W, whichever is greater. The performance of the ergometer prototype under test is assumed to be in conformity with future production.

The power measurement described is slow in comparison with the torque perturbations, which are mainly caused by mechanical tolerances in the ergometer transmission. The factors used for the

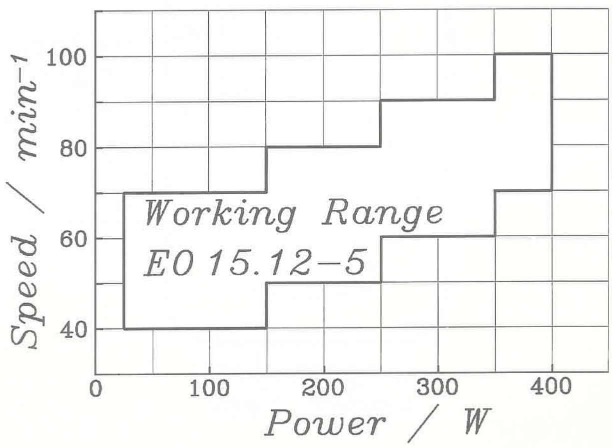

Fig. 1 Working range for rotation speed and power of medical ergometers to be tested.

mechanical power calculation are each measured with a different averaging time constant. Multiplication is applied to the measurands after averaging, therefore the phase relationship of their respective periodic components are not taken into account. This power measurement principle is not capable of measuring true mechanical power or separating reactive from true power. Reactive mechanical power – stored transient energy – is considered non-negligible here due to the inertia of the ergometer's flywheel and the compliance of its transmission; it must not be taken into account since the true power is the only quantity to be measured.

3 Dynamic testing of foot crank ergometers

In order to improve dynamic measurement, the PTB has developed an enhanced test apparatus for ergometer prototype approval. Since the torque transducer has a quick response, it remains unchanged, but the mechanical power consumption of the externally driven ergometer is now obtained with a high temporal resolution. This is accomplished by means of a new sensor for the instantaneous angular speed which allows erratic deviations of the power input to be detected and the true mechanical power to be measured, unaffected by reactive power. The check of the transients resulting from changing the operating set-point and the indication of mechanical irregularities are also distinctly improved.

4 Design and operation principle of the test equipment

Figure 2 illustrates the function of the dynamic test rig. The ergometer under test is clutched at its crank lever and linked to the torque transducer by means of a cardan shaft of adjustable length. The transducer is a commercial device based on a twisted-shaft sensor equipped with a rotating strain gauge bridge. Its signal is transmitted to the stationary part by means of telemetry via rotating transformers. The torque signal is fed to a personal computer equipped with a 12-bit data acquisition board.

The drive consists of a squirrel cage motor with field vector control for speed regulation. To avoid the disturbance of the computer and A/D converter by extremely noisy power electronics, the speed is set manually at present. In the future, an optical coupled interface to the PC is intended to be used. The drive's excess power avoids large speed excursions caused by the variable load. Remaining variations are taken into account by the encoder used here as a tachometer. A reducing gearbox adapts the speed to the range according to Fig. 1.

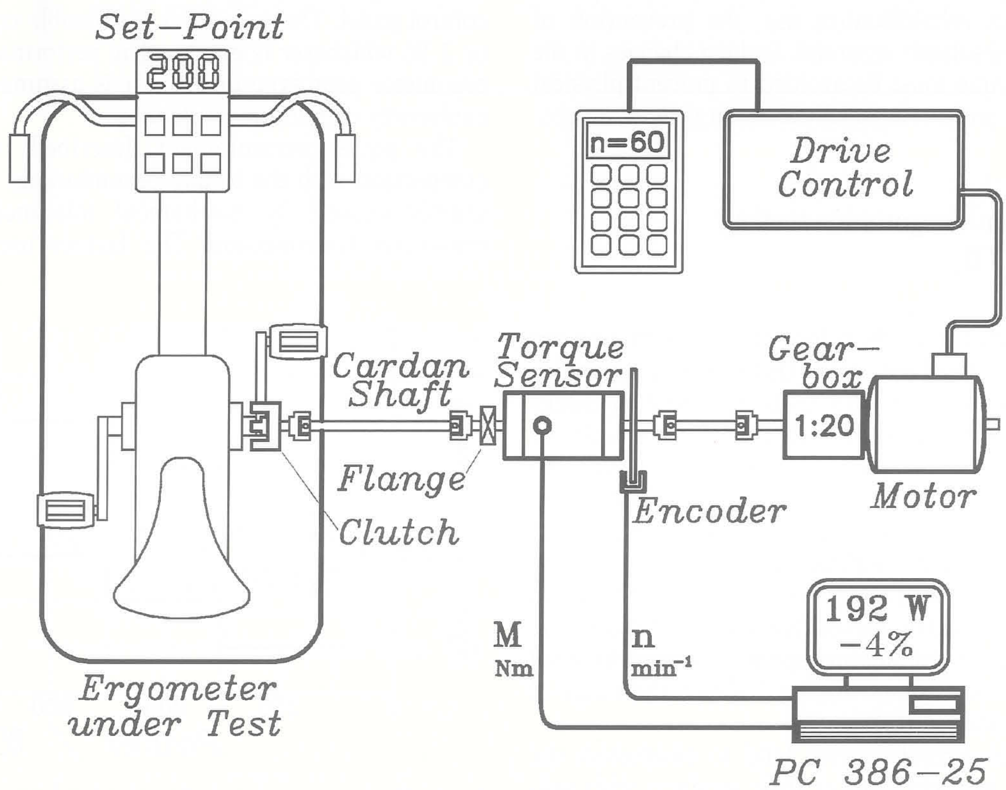

Fig. 2 Ergometer test rig of the PTB.

The rotation speed measurement is accomplished by a 600-period incremental optical encoder rotating at the same speed as the driving shaft. Every line passing the optical sensor generates an electric pulse that is evaluated for its distance in time to the previous pulse. This time interval is measured by reading the content of a quartz-controlled 10 MHz timer at the instant when an encoder line is passing. The instantaneous angular speed is then calculated in real-time as the reciprocal of the time interval.
The 10 MHz timer is part of the A/D converter module in the PC. The encoder pulses trigger the A/D conversion and start the software for counter reading.

5 Calibration and measurement accuracy

The maximum permissible error for ergometers is 5 % or 3 W according to [1]. The error permitted for manufacturer's equipment for production quality control is 2 % or 1.8 W, as laid down in the PTB Requirements PTB-A 15.12 [2]. It is intended not only to fulfill the requirements [1] for ergometer approval, but to achieve an accuracy better than that required by [2]. This would allow the described measurement principle to be applied in a future project for checking the ergometer test facilities at the production site. For the estimation of the overall error of the test rig, the measured speed and torque can be separated. The power is calculated as a product of frequency and torque and therefore their respective relative errors are not interrelated.

5.1 Torque calibration

The entire analog torque measurement chain (including the A/D converter) is calibrated statically without regard to the individual conversion coefficients of its components. The calibration elements of the torque transducer electronics are fixed and future drifts of gain and zero offset will be taken into account solely by the calibration procedure described below.

To calibrate the torque, the motor is blocked and a double-ended cantilever attached to the flange of the torque transducer, replacing the cardan shaft (see Fig. 2). The cantilever's length is defined by knife-edge bearings at a distance of 500 mm to the axis known with an uncertainty of less than 0.1 mm, i.e. with a relative error of less than $2 \cdot 10^{-4}$. The cantilever is loaded with weights having a relative uncertainty of less than 10^{-4} including the imbalance of the cantilever and the residual torque introduced by the knife-edge bearings. The product of lever length and gravitational force generates a torque signal that is repeatedly measured by the A/D converter, then averaged and stored as one calibration point. The nominal torque is known with a relative uncertainty of $2 \cdot 10^{-4}$ or 0.01 N·m at 50 N·m.

The bipolar range of the torque measurement chain is determined at seven values of torque settings which define seven calibration points. The individual calibration points are linearly interpolated and define a (nearly straight) polygon. The inverse function of this polygon is used as the torque calibration function. The reason for linear interpolation instead of polynomial fitting is a faster real-time computation. The calibration data for the transducer chain are stored in a disk file protected from inadvertent corruption by a check-sum. Deliberate changes of the file as well as damage to the analog channel are detected by repeated checks of the calibration status. Figure 3 compares the deviation of this seven-point calibration method (dashed line) with the deviation of the transducer with adjustment according to vendor specification only (continuous line). Though adjustability to within 0,05 N·m is claimed in the data sheet, we believe that only additional software-based calibration can achieve this accuracy (dashed line in Fig. 3).

The errors of the torque transducer due to rotation in subsequent operations cannot be taken into account by the static calibration procedure. This influence was checked in the Torque Laboratory of the PTB, and no effect was found within a detection limit of less than 10^{-3}. Another transducer imperfection is the cross-sensitivity to bending forces introduced into the mounting flange by the weight of the cantilever and the calibration masses. It was estimated to be negligible by qualitative assessment of its magnitude. The static friction of the journal-bearing could harm the torque calibration near zero torque. This influence is visible in the wider scatter of the measurements around zero

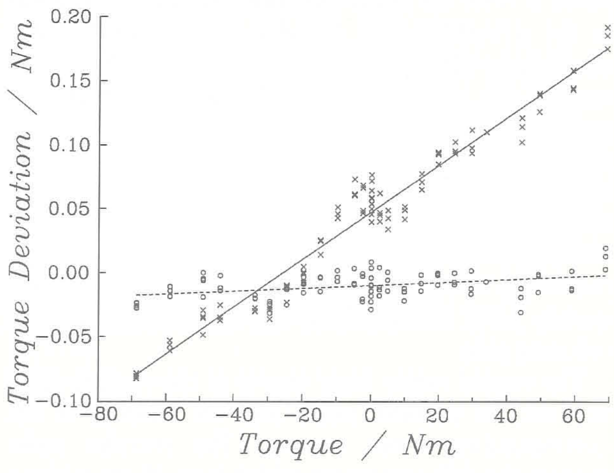

Fig. 3 Calibration of a torque transducer chain after adjustment according to vendor specification (solid line) and with subsequent correction by 7-point calibration (dashed line).

(Fig. 3), and an attempt has been made to reduce it by approaching zero from different preloads and by averaging. During the operational measurements, the values around zero are excluded by the working range (Fig. 1).

The total uncertainty of the torque measurement is deduced from the distribution width of repeated individual measurements (Fig. 3) and their long-term drift, both assumed to be 0.05 N·m or 10^{-3} of 50 N·m, five times the uncertainties of the calibration equipment.

5.2 Frequency calibration

The second quantity with a direct influence on the indicated power is the angular speed of the driven crank shaft represented by the frequency of the encoder pulses. An essential feature of this apparatus is the high temporal resolution speed measurement as mentioned above.

The reciprocal of the encoder period calculated to obtain the speed is nonlinear but it can be linearized for relative error considerations at the small deviations required here. The relative uncertainty of frequency equals the negative uncertainty of the period measurement. Some errors are too small to be considered further, e.g. the time base of the counter and the electronic jitter. Others are strongly correlated to adjacent values and require more consideration.

The largest variations are caused by the uncertainty of the period measurement introduced by the tolerances of the encoder wheel. One period of the incremental scale has a circumferential length of approximately 1 mm. Radial tolerance in mounting the encoder wheel gives rise to fluctuations of the encoder frequency that are periodic with the drive shaft's rotation. The relative amount of the frequency modulation is twice the radial mounting tolerance in relation to the circumferential encoder period. The encoder attachment needs very skillful radial adjustment, the success of which can be checked by means of graphically displaying the rotation speed measured with free-wheeling drive. From a residual frequency modulation of less than 1 %, it is deduced that the mounting tolerance is better than 0.01 mm which is considered to be the limit of the present encoder mounting. Its magnitude is comparable to the frequency noise introduced by the tooth meshing of the reducing gear.

The second major error source is the varying delay between an encoder pulse and the reading of the corresponding timer content. The encoder pulse triggers the A/D conversion which lasts 25 ms without noticeable variation. After completing the conversion, the A/D converter generates an interrupt to the PC with a constant delay of approximately 10 ms for the interrupt service initialization. An additional jitter is generated depending on the background software activity and on the interrupt channel priority of the PC. All the constant delays mentioned above (A/D converter, interrupt service initialization) do not harm the timing accuracy since they are equal in all periods and therefore eliminated in the determination of time difference.

The varying delay between the interrupt request and the time-critical reading of the timer content was carefully checked in several projects concerned with real-time applications of PCs running under MS-DOS. MS-DOS, normally not considered as a real-time operating system, revealed an unexpected fast and reproducible reaction. In this application all other interrupt sources can be disabled during the measurement of several turns of the crankshaft. The background software has only to make sure that the data collection by the interrupts has been completed, and to proceed after gathering the required amount of torque-speed pairs in a memory buffer. The power computation is performed after completion of the data collection by means of floating-point calculation.

Under these favorable conditions the residual jitter of the interrupt service is ± 0.8 ms (3 standard deviations), never exceeding 2 ms on a PC 386 with a 25 MHz clock. Precautions against overrun errors (lost interrupt requests) can be taken by prematurely enabling the interrupt system combined with a re-entry check in the interrupt routine. These are essential for interrupt frequencies above 20 kHz but also useful for detecting irregular interrupt intervals or noise pulses. The highest encoder frequency is 1 000 Hz (100 min^{-1}, 600 encoder periods). The corresponding time interval of 1 ms is influenced by the 1 ms interrupt jitter with a relative uncertainty of 10^{-3}, ten times less than the 1 % periodic variation due to eccentric encoder mounting.

The sum of the 600 angular intervals defined by the encoder must be equal to one revolution of the crank shaft. Consequently, the errors of individual encoder periods are not independent. One period length measured too long will shorten the next period measured, thereby eliminating the jitter influence over some intervals.

More serious is the periodic variation caused by an eccentric encoder wheel: its period correlates with the prevalent disturbance component of most ergometers, which is also periodic with the crank shaft revolution. This results in an error on the calculated power, depending, in sign and magnitude, on the phase difference between the two periodic error components. Cautious assumptions suggest a relative uncertainty of less than $2 \cdot 10^{-3}$ of the indicated power, having an ergometer with 20 % periodic component in the breaking torque.

6 Results

The error components have a major impact on different areas of the working range (Fig. 1). The speed uncertainty is slightly more pronounced at the higher encoder frequencies and always contributes less than 0.2 % to the total error. The torque uncertainty contributes an error of less than 0.9 % and 0.5 W to the indicated power at the two most critical points: 60 W, 70 min^{-1} and 25 W, 70 min^{-1} respectively [1]. Taking into account the maximum permissible error of 5 % or 3 W for ergometers, this is quite sufficient for ergometer prototype approval.

An unresolved problem due to lack of standardization is the assessment of the ergometer's dynamic behavior: periodic power fluctuations of 20 % during one revolution of the crankshaft plus some gear-wheel induced noise are quite normal even for well-designed ergometers (Fig. 4). This would be outside the permitted tolerances if such tolerances were applied to short-term power consumption. Considering the medical requirements, there is an agreement to average the power during three turns of the crankshaft, provided this averaged power is reproducible within the permissible tolerances. The reproducibility is verified by repeating every measurement three times. The averaging process applied to the fluctuating power is unlike the power calculation using averaged factors: due to the averaging of the power instead of the measured speed, the power obtained is inherently correct. Reactive components of the mechanical power within the frequency limit of the measurement channels are also rejected in the averaged power.

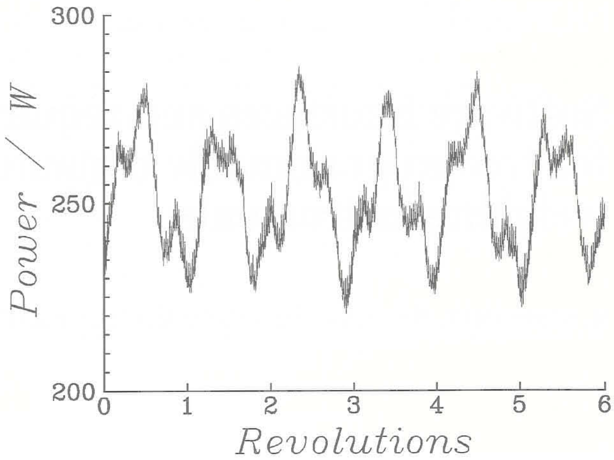

Fig. 4 Power fluctuation due to periodic torque perturbation of an ergometer at constant speed.

The manufacturer's quality control facilities for ergometers have to accomplish reduced error limits of 2 % or 1.8 W. With some improvements, the measurement principle is also suitable for checking these production test devices. An improved torque sensor and a computer-controlled torque generator for this purpose are being developed at present. ■

References

[1] Eichordnung, Anlage 15, Abschnitt 12, Tretkurbelergometer (Verification Ordinance Appendix 15, Annex 12), Deutscher Eichverlag Braunschweig (1990).

[2] PTB-Anforderungen PTB-A 15.12, Deutscher Eichverlag Braunschweig (1994).

NONAUTOMATIC WEIGHING

OIML Seminar
WEIGHING TOWARDS THE YEAR 2000
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Software interfaces and requirements for freeprogrammable nonautomatic weighing instruments

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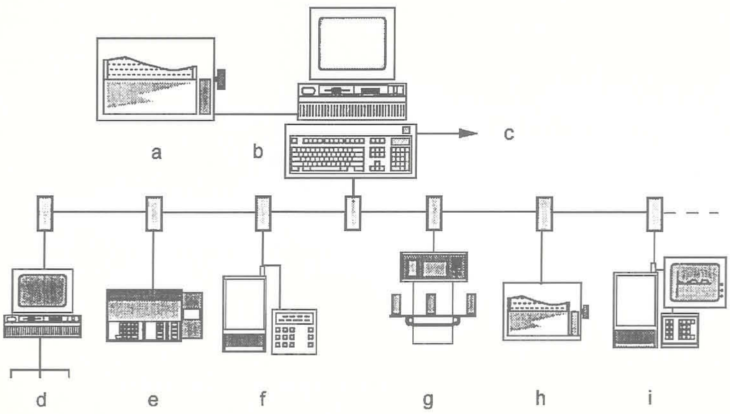
1 Introduction

Modern weighing technology is characterized by great strides thanks to microelectronics and data processing. The trend leads from compact independent instruments to weighing systems with computer-controlled data acquisition and analysis combined with check and control functions (Fig. 1).

Today, suitable interfaces for data exchange enable weighing instruments to be integrated in networks, such as commodity management systems or production management systems. Therefore, modern weighing instruments increasingly offer a wide field of applications not subject to legal control in addition to the elementary functions under legal control, such as mass determination, tare-weighing and possibly price calculation.

The problem with PC-based nonautomatic weighing instruments (NAWI) and modular weighing systems under legal control is to align the great flexibility of these intelligent devices with sufficient protection of the legally relevant functions against inadmissible changes. Moreover, an essential problem at the type approval stage of software-controlled instruments is the following: how to check that the existing requirements related to technical functions are appropriately implemented either in the hardware or in the software used for performing and controlling those functions. Thus, in spite of worldwide, uniform regulations for NAWIs under legal control, there does not yet exist a uniform interpretation with regard to the software examination and documentation for freeprogrammable instruments and devices such as indicators, data storage devices and point of sales devices (POS).

This paper is intended to present a new approach within the European Community (EC) towards the harmonization of software requirements and software examination for type approvals of freeprogrammable NAWIs. A respective document of the European co-operation in legal metrology (WELMEC) has been published recently [1] and currently serves as a preliminary basis in the context of EC type approvals. Following is an explanation of the background, conception and software requirements of this new approach.



a - printer, b - data processing PC, c - connection to a back-office PC, d - subsystem with several load receptors, e - weighing terminal for industrial application, f - subsytem, g - checkweigher, h - optional printer, i - subsystem with keyboard and monitor

Fig. 1: Structure of a commercial modular weighing system within a local area network.

2 Necessity of a harmonized software examination

The software of measuring instruments has become increasingly important and thanks to improved microelectronics, software takes over more and more functions from the hardware. Thus, NAWIs in particular have developed into microprocessor-controlled, multi-purpose instruments characterized by easy operation, short time of measurement and relatively trouble-free operation by automatic correction for influence and disturbance factors, weighing data processing and the possibility of an integration in a local area network (LAN) (Fig. 1). With an increasing complexity of software, however, there is a growing risk of unexpected malfunctioning or even fraudulent use. Therefore, the protection of software against unintended or intentional misuse is essential not only in legal metrology, but also within the scope of the manufacturers' quality assurance systems.

The EC Directive 90/384/EEC [2] states some essential requirements for protection against changes, manipulation or fraudulent use of NAWIs; in principle, such requirements must also be applied to the software controlling these instruments (Annex I, Nos. 8.1 & 8.5; Annex II, No. 1.7).

In addition, the European Standard EN 45501 [3], which is almost identical to OIML Recommendation R 76-1 [4], specifies the metrological and technical requirements for NAWIs under legal control in order to meet the essential requirements of EC Directive 90/384. The requirements of this European Standard apply to all devices performing the functions that are subject to legal control, whether they are integrated in an instrument or manufactured as separate units. However, the respective regulations describe neither the commonly accepted software examination and approval procedures, nor the proper documentation of the software examination results.

Accordingly, the experience of various European notified bodies in performing type approval examination of NAWIs has shown that the above regulations urgently needed a uniform interpretation with regard to intelligent, user-accessible NAWIs in order to avoid an unequal treatment of applicants.

3 The new approach with the WELMEC software guide

The WELMEC software guide [1] is a new approach towards the harmonization of software requirements and software examination in the EC. It applies to *freeprogrammable*, PC-based devices which are linked to, or form part of, NAWIs that are subject to legal control.

Figures 2 and 3 schematically illustrate the structures of the hardware and software of a PC-based weighing system which comprises devices and functions subject to legal control (inside the circles) and those not subject to legal control (outside the circles). Both figures are intended to serve as examples for demonstrating the basic principles of the WELMEC guide rather than as sophisticated models covering all possible technical solutions.

The basic instrument is the NAWI, which comprises at least a load cell, a load receptor, a microprocessor system including an A/D converter and a weight display.

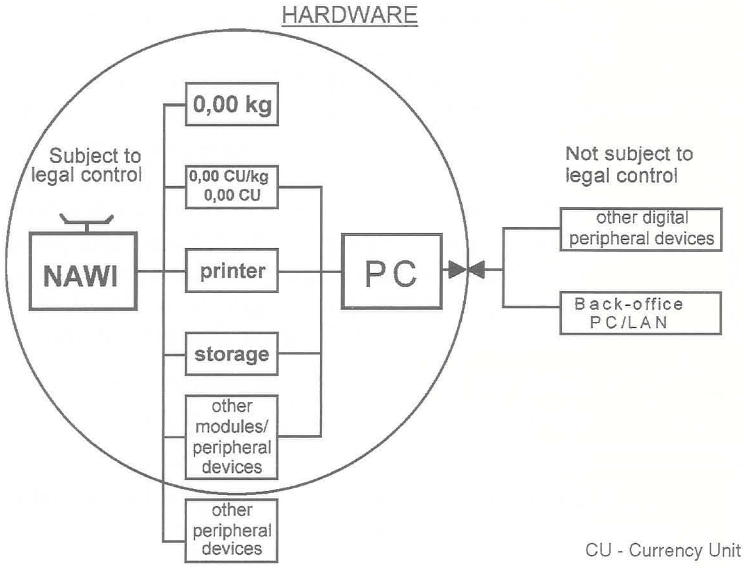


Fig. 2 Example of the hardware structure of a PC-based weighing system.

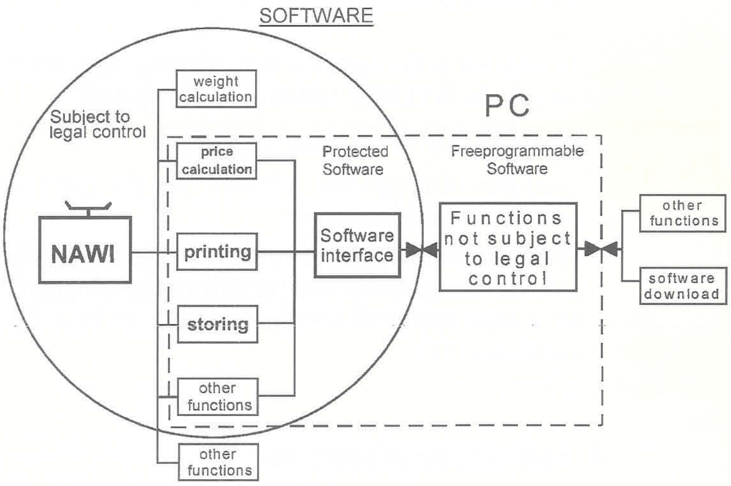


Fig. 3 Example of the software structure of a PC-based weighing system.

The basic instrument, in combination with separate modules or peripheral devices if necessary, may perform further functions subject to legal control, such as price calculation, price indication, printing or storing of weighing results and other functions, e.g. tare balancing, preset tare. Other peripheral devices not subject to legal control may be connected to the NAWI if the respective hardware interfaces are protective as specified in EN 45501, No. 5.3.6.1.

Today, freeprogrammable modules and peripheral devices, for example POS devices, take over an increasing number of legally relevant functions from the NAWI, e.g. printing of weighing results or price calculation. In this case, the *hardware* of the PC-based device is subject to legal control (Fig. 2). The *software* of such a device performs functions that may or may not be subject to legal control (Fig. 3).

The objectives of the WELMEC software guide are to:

- Define the basic requirements to be met by the software in order to have a *freeprogrammable* software part which can be adapted to the special needs of the application, as well as a *protected and approved* software part realizing legally relevant functions. The separation of the freeprogrammable and the protected and approved parts can be achieved by a *software interface* (Fig. 3), which itself is protective;
- Define the level of protection against *manipulation* and *simulation* of the legally relevant software *by the user* of the instrument;
- Enable the implemented software of a freeprogrammable instrument to be confirmed at verification by means of a *software identification* for the approved software; and
- Harmonize *software examination* and *documentation* by the notified bodies as part of the type approval and testing procedures for NAWIs.

In addition to the essential requirements explained in section 4, the WELMEC software guide contains:

- an explanation of the *terminology* used,
- examples of *acceptable solutions* for the essential software requirements, and
- recommendations concerning the *report* on the software examination and the *specifications* required in a type approval certificate (TAC) or in a test certificate (TC).

4 Software requirements

The WELMEC Guide 2.3 specifies the four essential software requirements as explained hereafter.

4.1 Protection of the legally relevant software

The legally relevant software shall be protected against intentional changes with common software tools.

Intentional changes with common software tools are defined as changes of the legally relevant software that are performed using functions of its own or software tools and know-how commonly available to the general public. At the moment, for example, all kinds of text editors are regarded as common software tools.

The program parts and data of the legally relevant software will be regarded as sufficiently protected against *unintentional changes* if the above requirement is met.

The protection against *intentional changes with special software tools* is not the object of these requirements since those changes are considered as criminal actions which are covered by existing laws.

4.2 Software interfaces

Interfaces between the legally relevant software and the software parts not subject to legal control shall be protective.

If parts of software exist besides the legally relevant parts, these parts shall be separated in a sense that they communicate via a software interface (see Fig. 3). A software interface is defined as being protective if, in accordance with EN 45501 - No. 5.3.6.1, only a defined set of parameters and functions of the legally relevant software part can be influenced via this interface; and if both parts do not exchange information via any other link.

Software interfaces are part of the legally relevant software. They comprise program modules and data structures. Circumventing the protective interface *by the user* is considered as a criminal action if the software is protected in the sense of No. 4.1.

4.3 Software identification

There must be a software identification, comprising the legally relevant program parts and parameters, which is capable of being confirmed at verification.

Legally relevant program parts and parameters are defined as shown in Fig. 4 and some examples are given in Table 1. The software identification may be split into two parts: one comprising the non-adjustable, type-specific functions and parameters, and the other comprising the device-specific parameters (see Fig. 4 and Table 1).

The operating system of the PC and other auxiliary software, such as video drivers, printer drivers or hard disk drivers, need not be included in the software identification. However, special application software made by or by order of the instrument manufacturer shall be included in the software identification if those program parts affect the printer or display which are subject to legal control (e.g. software parts realizing the layout and printing of a receipt).

Although the operating system and the auxiliary software of the PC need not be included in the software identification, a *change* of it shall be announced to the responsible notified body according to Directive 90/384/EEC, Annex II, No. 1.7.

A simple *update* of the operating system need not be announced because it is regarded as a minor modification which does not alter the characteristics of the legally relevant software.

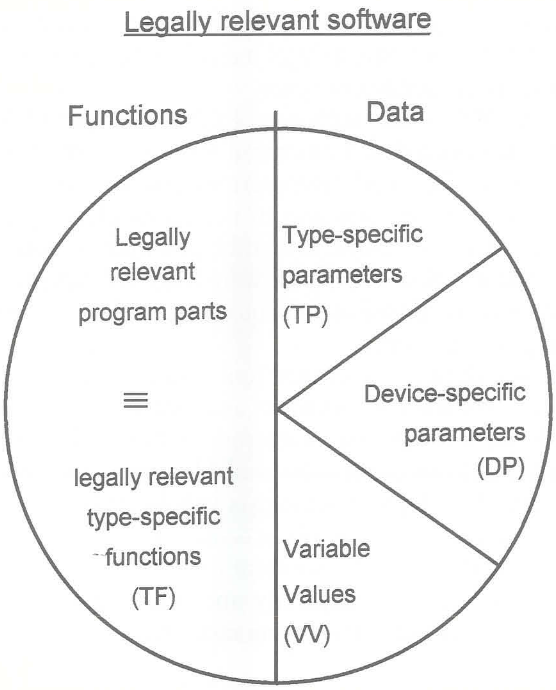


Fig. 4 Schematic representation of the legally relevant software comprising legally relevant program parts (functions) and data.

Table 1 Examples of legally relevant functions and data for NAWIs. *Note: The abbreviations used under "Type" are given in Fig. 4.*

Functions, data	Type
Weight calculation	TF, TP
Stability analysis	TF, TP
Price calculation	TF, TP
Rounding algorithm for price	TF, TP
Span (sensitivity)	DP
Corrections for non-linearity	DP (TP)
Max, Min, e, d	DP (TP)
Units of measurement (e.g. g, kg)	DP (TP)
Weight value as displayed *(rounded to multiples of e)*	VV
Tare, preset tare	VV
Unit price, price to pay	VV
Weight value in internal resolution	VV
Status signals *(e.g. zero indication, stability of equilibrium)*	VV

4.4 Software documentation

The WELMEC software guide is intended to be a preliminary document which describes the examination of the *functional description* of the software rather than its *practical testing*. Therefore, the following requirement concerning the software documentation is of major importance.

The documentation shall describe the following:

- all legally relevant parts and parameters of the software;
- the functions of these parts;
- the complete set of commands to be exchanged via the protective software interface;
- a written declaration of the completeness of the list of the legally relevant functions and parameters and the documented set of commands;
- the securing measures (e.g. check sum or other software identification, event counter or other audit trail);
- the instructions to check the legally relevant software at verification; and
- a written declaration that the standard EN 45501:1992/AC 1993 has been adopted.

5 First experiences with the WELMEC software guide

Since the adoption of the WELMEC Guide 2.3 in January 1995, several manufacturers of freeprogrammable NAWIs and modular weighing systems have shown great interest in this new approach, as shown by the data in Table 2. This Table shows that at present, manufacturer interest in freeprogrammable devices focuses on EC test certificates, especially for digital indicators.

Table 2 Number (nr) of inquiries, applications and certificates on the basis of WELMEC Guide 2.3 arrived at or issued by the PTB in the period January – August 1995.

	EC test certificates		EC type approvals
	Nr	Type	Nr
• Issued	1	DI	–
• Applications	2	DI	2
• Applications expected shortly	3	DI, POS	–
• Enquiry (preliminary meeting)	2	DS, POS	–
• General enquiry	4		2
Sum	**12**		**4**
DI = digital indicator; DS = data storage device; POS = point of sales device			

Taking into account several discussions with various manufacturers, the present experiences with the new WELMEC approach can be summarized as follows:

- The software requirements are predominantly regarded as appropriate, useful and well understandable, at least to software engineers.
- Software requirements can be met with few additional efforts if they are taken into consideration from the beginning of the software conception. It is advisable to manufacturers that they discuss their preferred solution as early as possible with the notified body.

Meanwhile, the PTB has developed a checklist according to WELMEC Guide 2.3 which has proved to be helpful for both the manufacturer and the notified body in checking whether the required documentation and specifications have been supplied.

The level of protection against manipulation, i.e. the protection against changes with common software tools, seems to be sufficient for NAWIs.

Some problems arise when the protected and approved software are supplemented by new program modules as is the case, for example, for drivers for additional or new weighing instruments, load receptors or printers. A solution must be found for guaranteeing the protection against manipulation without changing the checksum or other software identification any time a new driver has been added.

Manufacturers welcome the preliminary procedure, i.e. the examination of the functional description of the software only. From the point of view of notified bodies, at least a few spot checks appear to be necessary in order to verify the documented functioning of the software.

6 Summary and outlook

Software takes over an increasing number of functions from the hardware, thereby determining the technical and metrological properties of measuring instruments. Therefore, software examination is of significant importance, not only in legal metrology but also within the scope of quality assurance.

The WELMEC software guide is a promising approach towards a harmonized software examination, at least for PC-based, freeprogrammable devices which are linked to, or form part of nonautomatic weighing instruments. Of course, it is still a preliminary working document which, like the software itself, will have to be permanently revised and adapted to new developments and practical needs.

A standardized software tool and/or standardized expert system for software examination would be desirable for both manufacturers and notified bodies, but these do not seem to be available in the near future. Nevertheless, legal metrologists should undertake the development of commonly accepted software requirements and software examination methods that are adequate for the complexity and great flexibility of modern, 'intelligent' measuring instruments. ■

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TOWARDS QUALITY IN FLOW MEASUREMENT

Development of a reference flow measurement laboratory in Brazil

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Abstract

Flow measurement is one of the most important industrial process variables from an economical point of view, and has perhaps the most complicated procedure for being transmitted from a reference laboratory to the final user in a traceability chain. In addition, flow measurement is associated with the largest uncertainties and its correct measurement is normally very difficult, even in ordinary applications.

This article briefly describes why flow measurement laboratories have become important in recent years and gives an overview of the situation concerning flow measurement traceability in Brazil. Details will also be given as to the new facilities of the Flow Laboratory of IPT, which is presently undergoing an accreditation process in order to become the Reference Flow Laboratory in Brazil.

Introduction

Flow rate is the last parameter of the industrial process to be metrologically organized in Brazil. Although INMETRO – *Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (Brazilian National Institute of Metrology, Standardization and Industrial Quality)* – has been in charge of the traceability chains for several other parameters such as temperature, length, pressure, current, force, etc., there was no possibility for establishing a flow measurement laboratory in its facilities.

Since 1982, flow measurement techniques have been developed at the state-owned Institute for Technological Research, known as IPT *(Instituto de Pesquisas Tecnológicas do Estado de São Paulo)*, and in Dec. 1994 a new facility for the calibration of gas meters, water meters and velocity of fluids was inaugurated. In partnership with INMETRO, this facility will soon serve as the Brazilian Reference Laboratory for Flow Measurement.

The importance of flow measurement

Flow rate is not a primary quantity like mass, length, time or temperature and it is a rather difficult quantity to be carried out as a standard for a number of reasons:

- the propagation of errors is quite quick because the flow rate calculation depends on primary quantities and many composed quantities like pressure, density, viscosity, etc.;
- it is a dynamic quantity and there is always the possibility of a strong influence of the laboratory facilities on the meter under test,
- there is no such thing as a standard m^3/s or kg/h: it is impossible to give someone a m^3/s as a materialization of a standard flow rate. The transfer of a flow rate in the metrological chain of a country is therefore very different from the transfer of the kilogram or the meter.

For these reasons, when an uncertainty of 0.5 % is achieved, it may be considered as a good result.

The importance of reliable flow measurement has been described by many authors: in the Netherlands, a 0.1 % uncertainty means more than USD 3.2 million/year of an incorrect transfer of money in the exportation of natural gas alone [1]; in the USA, an additional uncertainty of 0.1 % in the measurement of natural gas means USD 50 million [2] of incorrect transfer of funds, and in Great Britain (3), the same 0.1 % might mean USD 8 million/year. Because 0.1 % is a very difficult level of uncertainty to be distinguished in flow measurement, one may consider that ordinary errors in flow measurement may concern large sums of money.

The increasing importance of flow measurement laboratories

From the 1940's up to the late 1960's, a number of countries established primary flow laboratories, in search of a good metrological basis that could assure reliability and reduce conflicts between customers and sellers of flow products. At this time, oil and water were extremely inexpensive, and due to the belief that the natural resources were inexhaustible, there existed no rigid need for process control. International economic relations were not as competitive as they are today, the transfer of gas and oil through pipelines was not as developed and, helping to create this "romantic" environment, electronics was not an important technique for flow measurement and there was little aggregated knowledge of measurement errors.

In the beginning of the 1970's, the petroleum crisis presented a challenge to the world: a significant increase in prices led to severe control of commodities, past wastefulness of resources was no longer allowed and new habits of consumption were assumed out of ecological concern for the preservation of natural resources.

At almost the same time, a general recession produced a desperate search for more efficiency in order to improve the competitiveness of the broad economic sectors in various nations; flowmeters started receiving much more attention due to the fact that they are important control tools in most industrial processes.

For all these reasons, correct flow measurement became an important objective in metrology. By this time, all developed countries had established primary laboratories which spread traceability chains for the various aspects of flow metering activities.

Within 15 years after the oil crisis, there was a well-established international intercomparison net among the best laboratories, thus raising the level of knowledge as to meters and flow measurement techniques. Among the most important flow laboratories participating in these intercomparison tests were NEL (National Engineering Laboratory, UK), PTB (Physikalisch-Technische Bundesanstalt, Germany), NIST (National Institute for Standards and Technology, USA), NMi (National Measurement Institute, Netherlands), SFOM (Swiss Federal Office of Metrology) and NRLM (National Research Laboratory of Metrology, Japan) [4].

Other important factors contributed to development in this area, such as new electronics that were incorporated into the flowmeters, the intensive use of natural gas, and the beginning of the great exportation of gas to Europe through pipelines from the North Sea and the former U.S.S.R.

Finally, at the end of the 1980's and in the beginning of the 1990's, developing countries recognized the need to establish flow measurement laboratories in order to initiate the traceability chains for flow measurement. This was the case for South Korea (KRISS - Korean Research Institute of Science and Standards), India (FCRI - Fluid Control Research Institute) and more recently, Brazil (IPT) and Mexico (CENAM - Centro Nacional de Metrologia).

Situation in Brazil

The history of natural gas has just begun in Brazil; although about 10 million m^3 is being sold per day [5], there is a good perspective for this figure to increase to more than 50 million m^3/day by the year 2000, due to new pipelines from Bolivia and Argentina, and to a Brazilian offshore platform.

There are around one million diaphragm meters and 16 million water meters installed in the country. In addition, Brazil has a chemical and petrochemical park which ranks as one of the 10 biggest in the world; it has one of the biggest orange juice and alcohol complexes; and it probably ranks 5th in the pulp and paper sectors throughout the world; there are also many flowmeter manufacturers installed in the country. For these reasons, there was an urgent need for an adequate level of quality in the area of flow measurement in Brazil.

The Flow Laboratory of IPT

Figure 1 shows the basic diagram of the traceability of flow measurement in Brazil. INMETRO provides traceability of the basic quantities to the country, including the IPT Flow Laboratory [6].

In the diagram, foreign flow measurement laboratories are shown because it is very difficult to evaluate systematic errors in a flow laboratory without international comparisons with laboratories that are responsible for maintaining flow measurement standards in their countries, like the PTB, SFOM, NEL, NIST, etc.

This kind of arrangement for flow measurement is not new in the world: there is a similar situation in the United Kingdom, where NPL (National Physical Laboratory) is in charge of the standards of all quantities except flow measurement, which is under NEL's responsibility.

Facilities for gas flow measurement

This facility was designed to calibrate gas meters from 0.001 m^3/h to 3 600 m^3/h, and up to 50 000 m^3/h under less controlled situations, as will be explained later. It was designed by the staff of the IPT Flow Laboratory after many contacts with other flow measurement

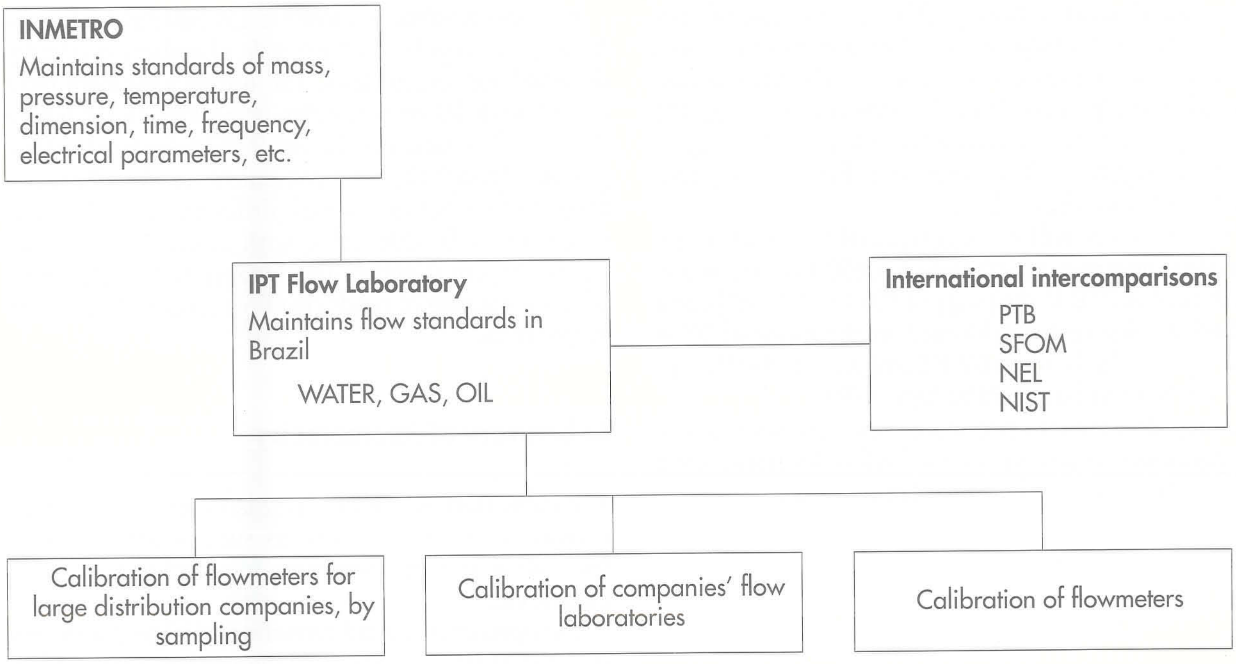

Fig. 1 Metrological chain for flow measurement in Brazil.

laboratories in the world. Members of the Laboratory spent periods abroad, particularly at NEL, in order to learn new techniques and to study matters related to design.

In Fig. 2, two bell provers (500 L and 4 000 L), designed and built at IPT, are shown together with a bench that uses wet gas meters as standards, as described in Table 1. In this facility, it is possible to perform all the tests described in OIML Recommendations R 6 and R 31 for the pattern approval of diaphragm meters [7].

On the other side of the laboratory, the high flow rate rig uses three turbine meters (G400, G650 and G1000) and three CVM (ranging from 6 to 300 m^3/h). The standard meters can be used alone or in parallel, thereby allowing the flow rate to be raised up to 3 000 m^3/h. Air is aspirated through the meter under test, deviated to the standard meter (or standard meters in parallel), passed through the aspirating fan and returned to the testing room in order to be conditioned again. All standard meters have flow conditioners installed upstream.

Table 1 Low flow rate gas facilities.

Method	Flowrate (m^3/h)		Uncertainty
	Minimum	Maximum	%
Burette and soap film	~ 0	0.002	± 0.5
500 L Bell prover	–	~ 40	± 0.3
4 000 L Bell prover	–	~ 300	±0.3
West test Meters	~ 0	24	± 0.5

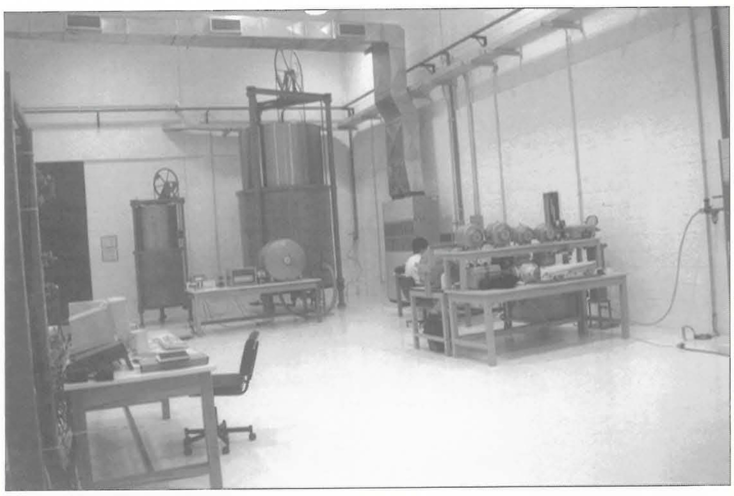

Fig. 2 Low flow rate gas facilities: the two bell provers are shown just behind the bench of wet test meters.

The special arrangement of this rig allows for a very easy intercomparison of one standard meter against another, which helps in cases where doubts arise during a calibration process. It is also practical to make the scale up in flow rate from the bell provers to the biggest turbine. Figure 3 shows this high flow rate rig and Table 2 shows its basic data.

These meters will be kept traceable through a calibration program which uses a G650 turbine meter calibrated at PTB in the range of 100 to 1 000 m^3/h, and a G65 turbine meter calibrated in the range of 10 to 100 m^3/h at the factory (GWF Company), at SFOM and at PTB. Both turbines will be kept at IPT.

A new flow rig with two sets of sonic nozzles is under preparation and this will be used either for transferring traceability or for calibrating other flowmeters.

Table 2 High flow rate gas rig.

Method	Flowrate (m^3/h)		Uncertainty
	Minimum	Maximum	%
CVM (rotary pistons)	0.6	300	from ± 0.3 to ± 0.5
Roots meter	0.3	400	from ± 0.5 to ± 1.0
Turbines –	32	3 000	± 0.5

It is also possible to calibrate gas flowmeters in very large flow rates by using nozzle chambers originally designed for testing fans. The nozzle chambers have a wall with 10 or 6 nozzles (type ISA 1932) where different flow rates can be obtained by sealing the flow passage through the most convenient nozzles. There are three nozzle chambers with different sizes that can reach up to 50 000 m^3/h, with uncertainty around 1.5 %. Figure 4 shows the biggest nozzle chamber, which is capable of producing flow rates from 2 000 to 50 000 m^3/h.

Laboratory of Anemometry

The Laboratory of Anemometry is used to calibrate air velocity measuring instruments such as anemometers, hot wire or film anemometers, meteorological anemometers, etc.

The open circuit wind tunnel was designed and constructed at IPT according to the models developed in the past at the National Physical Laboratory (NPL). This wind tunnel is operated by a centrifugal fan. Downstream the fan, a diffuser expands the flow, passes through three screens, mesh 20, strings with diameter of 0.385 mm, and through a honeycomb with hexagonal cells with a diameter of 7 mm, thickness of 0.05 mm and length of 140 mm. Downstream, there is a section for stabilization and a super contraction, calculated according to the 3 W method [6].

The instruments are calibrated at the open jet section in the range of 1 to 45 m/s. The standard instruments are a mechanical anemometer, several Pitot tubes and a hot film anemometer which is traceable to NIST. Figure 5 shows the wind tunnel being adjusted to calibrate an anemometer.

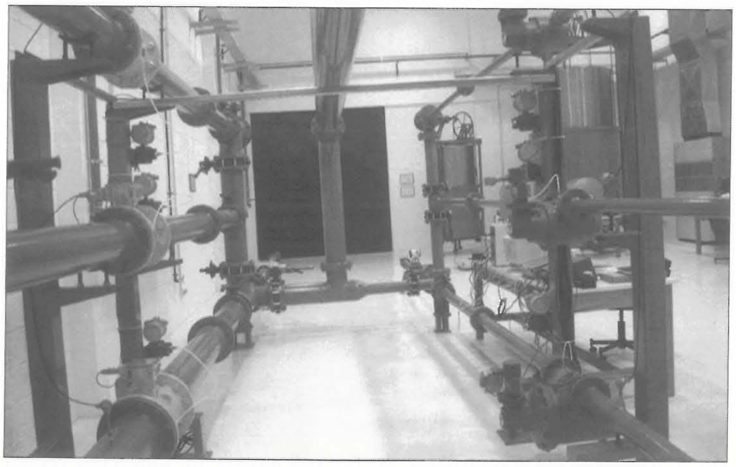

Fig. 3 Internal view of the high flow rate rig.

Fig. 4 Nozzle chamber.

Water Laboratory

This laboratory can calibrate water flowmeters up to 700 m³/h using the gravimetric method. There is an underground reservoir of 35 m³, and pumps may send water either directly to the test lines or to a constant level head tank. The constant level head tank is 16 m above the floor, and the pumps (60, 40 and 20 hp) can provide 42 m of head, directly in the test lines.

The meter under test is placed in the middle of the test lines of 4" or 8", and the flow is driven to one of the two weighing tanks, one with 1.5 tons and the other with 4.5 tons, supported by load cells with 100 g resolution. Both tanks have independent circuits with flowrate adjusting valves. Diverter valves deviate water either to the weighing tanks or to the return circuit, to the underground reservoir.

The load cells can be calibrated daily through weights placed in a special cart that runs on tracks. The cart, loaded with 40 calibrated weights of 25 kg each, distributes the calibration weights over the structure of the load cells by means of a pneumatic circuit, and can be used to calibrate both weighing tanks. The calibration process can be completed in a few hours or in a few minutes, depending on the number of points to be calibrated. Figure 6 shows a view of the Water Laboratory.

Fig. 5 Wind tunnel under preparation for a calibration test.

Fig. 6 Water Laboratory.

Conclusion

At last, there are favorable conditions in Brazil for the establishment of a traceability chain for flow measurement due to the inauguration of the new facilities of the IPT Flow Laboratory. Relations with primary laboratories abroad have been established in order to complete a set of intercomparison tests for several flow rate ranges. There is an agreement being discussed by IPT and PTB which would allow for a complete "round robin test", with important results for Brazilian metrology in the area of fluids.

The challenge now is to unify all the small flow measurement traceability chains that are spread throughout Brazil into a single, national chain. This would assure the basic conditions necessary for providing the users with safe and reliable flow measurements. ■

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INTERNATIONAL EXCHANGE

The OIML international round table on "Confidence in type approval"

26 October 1995, Beijing

An international round table was organized by OIML on 26 Oct. 1995 in Beijing, in conjunction with its 30th CIML Meeting. The discussion focused on **Confidence in type approval,** *a topic of growing importance to the international metrology community.*

The OIML round table was attended by some 50 participants from about 30 countries, and chaired by S. Bennett, Chief Executive of the National Weights and Measures Laboratory (NWML) in the U.K. and CIML Member. Discussions were led by Mr Bennett and a panel of four experts: K. Lindløv (Norway), S. Chappell (U.S.A.), J. Basten (Netherlands), and J. Birch (Australia).

The OIML round table was organized with a view to providing an informal forum for the exchange of views between international metrology experts who are increasingly confronted with issues of accreditation, certification and confidence between countries and regions with regard to type approvals.

Following a welcoming address by Mr G. J. Faber, CIML President, an extensive introduction by Mr Bennett highlighted the scope of the proposed topic, which centered mainly on the fact that, while confidence in the metrology community was formerly based on local expertise within national legal metrology services, it takes on a different dimension in view of the international marketing of measuring instruments, and the need to avoid unnecessary repetition of equipment testing. Therefore, a number of important questions can be raised as to the recognition of type approvals outside the country of issue.

Following is a brief summary of the main points and questions which arised during the round table discussion.

An international panel led discussions during the OIML round table on "Confidence in type approval" held on 26 Oct. 1995 in Beijing. *Pictured from left to right: K. Lindløv, S. Chappell, S. Bennett, J. Basten, J. Birch and B. Athané.*

What does confidence consist of?

In the first session of the round table, the basis for confidence was addressed by many speakers who pointed out several factors influencing the degree of confidence built between metrology services and laboratories. These include:

- knowledge of the issuing laboratory (Authority), whether it be through recognition agreements, or simply the fact that the Authority in question has an extensive history and experience, thus making it "well-known" throughout the metrology community;
- the test itself and its appropriateness in relation to certain specifications or requirements;
- the test result in terms of that which can be concluded from the result with regard to the product, and those characteristics which can be identified;

- the equipment submitted and the assurance that the originally approved or certified type is representative of the actual instrument submitted for market use; and
- the technical quality of the Standards and Recommendations, including their comprehensiveness and unambiguity.

Accreditation of the testing laboratory and/or Certifying Authority:

One step towards confidence

The subject of accreditation as a means for building confidence was discussed in length by the round table participants. Questions were raised as to whether accreditation should be mandatory or not, and which kind of accreditation should be pursued: general accreditation, or accreditation that is specific to the regulations and technical competence required, or to type approval activities. The general observation was that a distinction should be made between test laboratories and certification bodies: accreditation of the testing laboratories should be made by the normal laboratory accreditation system, whereas the definition of certification bodies (e.g. EC notified bodies) should remain the responsibility of the State. Several speakers also addressed concerns related to the economic implications of the subject, often mentioning the relatively high costs associated with third-party accreditation.

In addition to the "philosophical" aspects of the discussion on accreditation, questions directly concerning OIML and its approach were put forth: *What should the OIML policy be with regard to accreditation? In which way should OIML increase its interaction with international and regional accreditation bodies, such as ILAC and EAL, in order to ensure that OIML requirements are met by these other Organizations, and that legal metrology is correctly used in accreditation? How should the role of the OIML Certificate System and the acceptance of the issued certificates be increased?*

Despite the absence of any conclusive responses to such questions, participants agreed that the establishment and application of international criteria and methodologies in the area of accreditation would be a positive development for building confidence at national, regional and international levels of metrological cooperation.

Despite difficulties finding a *round table* for all the participants, the unofficial tone of the discussion contributed to the numerous interventions made by several different speakers.

The round table proposed further study of several relevant issues, including the role of measurement uncertainties in legal metrology and type evaluation systems, and the advantages and disadvantages of carrying out intercomparisons between laboratories.

As witnessed by the enthusiastic participation in the discussion on *Confidence in type approval*, the 1995 round table in Beijing will inevitably serve as a catalyst for the organization of future OIML events of this kind. This round table demonstrated that, through exchanges of views, information and suggestions based on the diverse experiences of metrology experts from all over the world, important progress can be set in motion for the future of metrology and related fields of activity. ■

OIML ROUND TABLE: SEVEN MAIN TOPICS FOR REFLECTION

1. UNAMBIGUITY OF OIML RECOMMENDATIONS AND NATIONAL REGULATIONS

Improving the technical clarity of Recommendations and regulations to facilitate a more harmonized interpretation of requirements.

2. COST OF CONFIDENCE

Balancing the desire for greater confidence in type approvals against the cost of achieving that confidence.

3. ACCREDITATION AND PEER EVALUATION

How far should accreditation by third party bodies be relied upon? and *How can confidence be developed through peer evaluation of systems and resources?*

4. PROMOTION OF THE OIML CERTIFICATE SYSTEM

Making the OIML Certificate System even more effective and increasing the acceptance of OIML certificates.

5. DEVELOPMENT OF CONFIDENCE AFTER TYPE APPROVAL

Pursuing further proficiency testing of test laboratories and performance testing of the product as a means of building on the initial confidence in a type approval authority.

6. COMMUNICATION AND INFORMATION

Building confidence through increased communication and information, knowing more about each other and understanding each other better.

7. HOLISTIC APPROACH

Seeing type approval as part of the whole process, from design through type approval, verification and manufacture, and use in the field.

OIML SYMPOSIUM PRESENTATION

METROLOGICAL ACTIVITIES IN DEVELOPING COUNTRIES

23–24 OCTOBER 1995
BEIJING, PEOPLE'S REPUBLIC OF CHINA

Metrology in China

R. DAI, China State Bureau of Technical Supervision (CSBTS)

Metrology, particularly legal metrology, has a long history in China and was recorded more than 3000 years ago. The first Emperor of China, Qin Shi Huang, issued a rule to unify the Weights and Measures, and developed some measurement standards for unifying the weight and volume units in the whole country. These early measures which guaranteed the uniformity of measurement were of great significance to the history of metrology all over the world.

The System of Weights and Measures has received great attention in Chinese history, despite a few differences between the Measures and Weights systems in the various dynasties that have existed.

After the founding of the People's Republic of China, modern metrology was set up and formally developed. In order to meet the requirements of the rapid economic expansion and defense construction, the Chinese government has taken a set of measures to promote and develop metrology.

We would like to introduce *Metrology in China* from four aspects: Metrology Law and Regulation System; Metrological traceability: suitable to the needs of economical development in China in principle; Metrology supervision: implementation for protecting customer interests; and OIML Conformity Certificates in China

1. Metrology Law and Regulation System

The Metrology Law and Regulation System in China includes two aspects as follows.

1.1 Laws and Measures on Administrative Control of Metrology

These include the Law on Metrology (approved by the China People's Congress), rules for the implementation of the Law on Metrology (promulgated by the State Council), and several measures promulgated by the State Council and the CSBTS (State Bureau of Technical Supervision of China). Figure 1 shows their relationships.

The main aims of the Law on Metrology of the People's Republic of China are: to strengthen the management and supervision of metrology; to guarantee the uniformity of measurement units in the whole country as well as the accuracy and reliability of the results of measurement; to contribute to the development of production, trade, science and technology; to meet the needs of social modernization and construction; and to safeguard the interests of the state and the people.

The content of the metrology law includes: Legal Metrology Units; The Establishment and Management of Primary Standards and Reference Standards; Setting up and authorizing of Metrology Service Units; Metrology Accreditation; Arbitration of Metrology Disputes; Metrology Supervisors.

The Metrology law stipulates that the Metrology Administrative Department should execute compulsory verification of those measuring instruments used for setting trade accounts, safety protection and medical treatment as well as health and environmental monitoring. The list of these has been published by the State Council.

Mr Li Chuanqing, Director General of CSBTS and CIML Member for China.

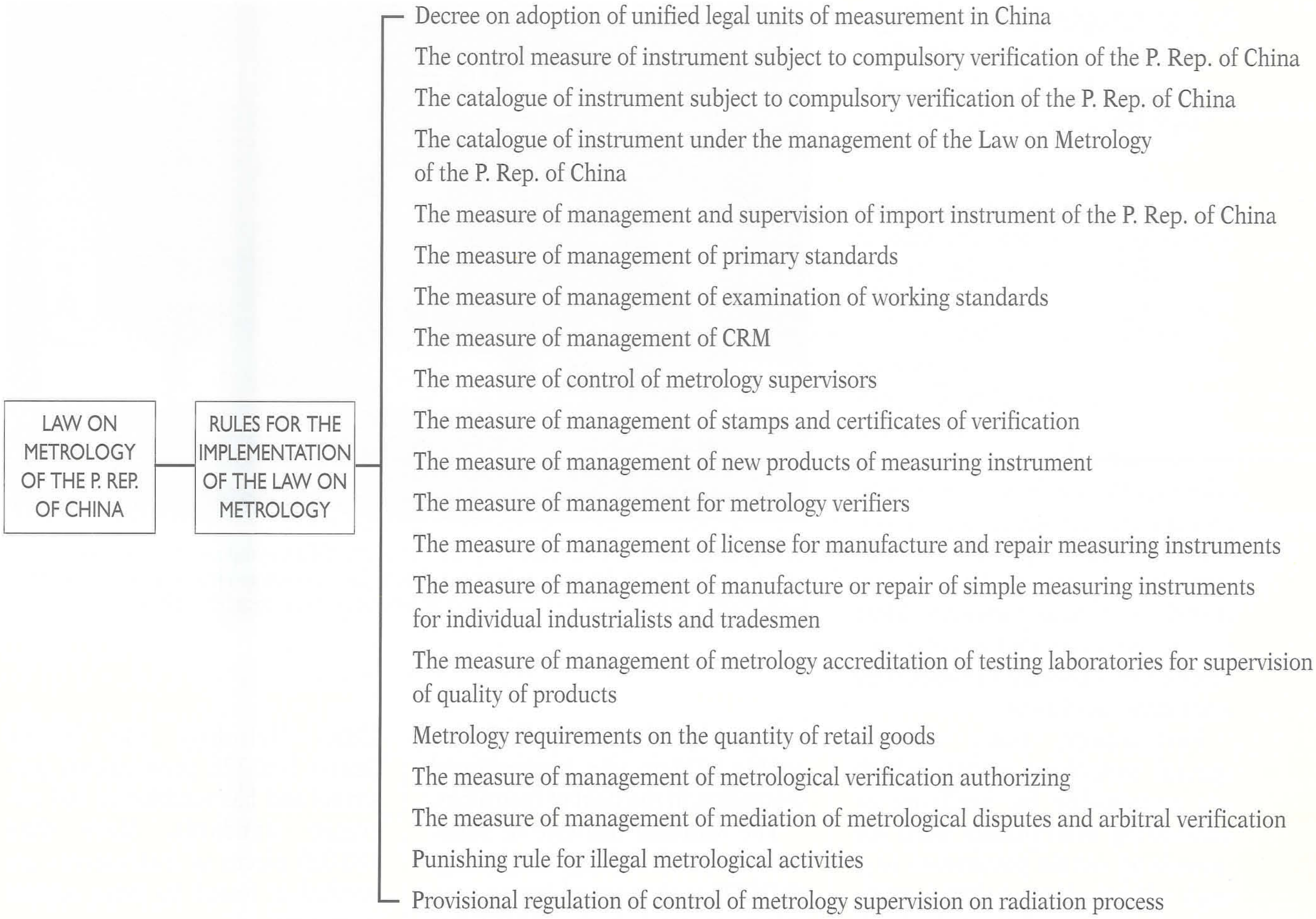


Fig. 1 **The Chinese Law on Metrology provides for several measures intended to strengthen the management and supervision of metrology.**

The procedures for managing the manufacture and use of measuring instruments include pattern approval for new types of instruments, initial and subsequent verification, and supervision of instruments being used. They are similar to those implemented in most other countries.

1.2 Technical regulations and norms

1.2.1 Verification scheme

This scheme includes a diagram and a statement including the name of instrument, capacity of measurement, method used in verification, etc. for primary standards to working instruments. It is just like the Hierarchy Scheme for measuring instruments described in OIML D 5. There are 89 verification schemes at present.

1.2.2 Verification regulations

The content of verification regulations in China includes the metrology requirements, items to be verified, method used in verification, verification interval, processing method for measurement results, etc. There are 880 verification regulations and efforts are being made to reform our regulations to increase their compatibility with OIML International Recommendations.

1.2.3 Technical norms

Technical norms are the procedures necessary for implementing metrology administrative management and supervision. At present, there are 189 technical norms.

2. Metrological traceability: suitable to the needs of economical development in China

Traceability is basically carried out at four levels in China. The State is responsible for developing or setting up primary standards and disseminating their values to reference standards set up by provincial metrology institutes. The provincial institutes are responsible for verifying the reference standards maintained by city institutes, and the city institutes are responsible for verifying the reference standards maintained by county institutes or manufacturers. Most of the working instruments are verified or calibrated in factories and county institutes.

Furthermore, there are 16 special metrology centers which are responsible for verifying or calibrating instruments used for measuring certain parameters (e.g. high voltage, large volume, parameters used in the textile field, etc.). Figure 2 shows the metrological traceability system in China.

The main task of establishing national primary standards is under the responsibility of the National Institute of Metrology (NIM). NIM has established the primary standards for six SI base units (except *mole*), which have participated in international comparisons with good results in the past.

There are also 113 kinds of national standards for different parameters established and maintained by NIM, except those in the field of chemical metrology. NIM has 12 technical divisions, 68 laboratories and a staff of 1 600, including 1 000 technical persons, 300 of which are senior scientists and engineers. BIPM has maintained one set of electrical standard cells made in China and with good stability. NIM has developed a platinum resistance thermometer for measuring high temperature with good performance. All of these enable NIM to win international reputation in the field of metrology.

Among those present at the opening session of the OIML symposium were *(from left to right):* Li Chuanqing, Director General of SBTS, Xu Penghang, Vice-Minister of the State Commission of Economy and Trade, and M. Kochsiek, Vice-President of CIML.

The National Institute of Measurement and Testing Technology (NIMTT) is the second largest metrology research body. NIMTT has established 17 national standards and 25 working standards, and has a staff of about 500 persons. Together with NIM, NIMTT has provided experimental data for changing the value of the unit of volt in 1990 and that of photometry in 1979. More than 70 000 pieces of instruments are verified or tested in NIMTT every year.

The National Research Center for Certified Reference Materials (NRCCRM) is a state professional institute for the research and development of standards for chemical metrology. NRCCRM has a technical staff of 110 and has developed 120 certified reference materials which have been exported to some other countries. The office of the examination council for certified reference materials in China is also located in NRCCRM.

There are 18 State Metrology Centers in economical cooperation zones. For example, the North China Metrology and Testing Center has 326 professional personnel and has established 161 reference standards. More than 110 000 pieces of instruments are verified or tested by these centers every year.

There are 18 State Metrology Centers in special fields which contain more than 1 166 scientific and technical personnel. These centers verified or tested nearly 79 250 pieces of instruments in 1993. In addition, there are 35 provincial metrology institutes, more than 300 city metrology institutes and approx. 2 000 metrology units at county level in China. They contain 60 000 staff members and about 28 000 000 instrument pieces are verified or tested by them annually.

3. Metrology supervision: implementation for protecting customer interests

In order to protect the interests of customers, metrology supervision has been implemented in the following four fields.

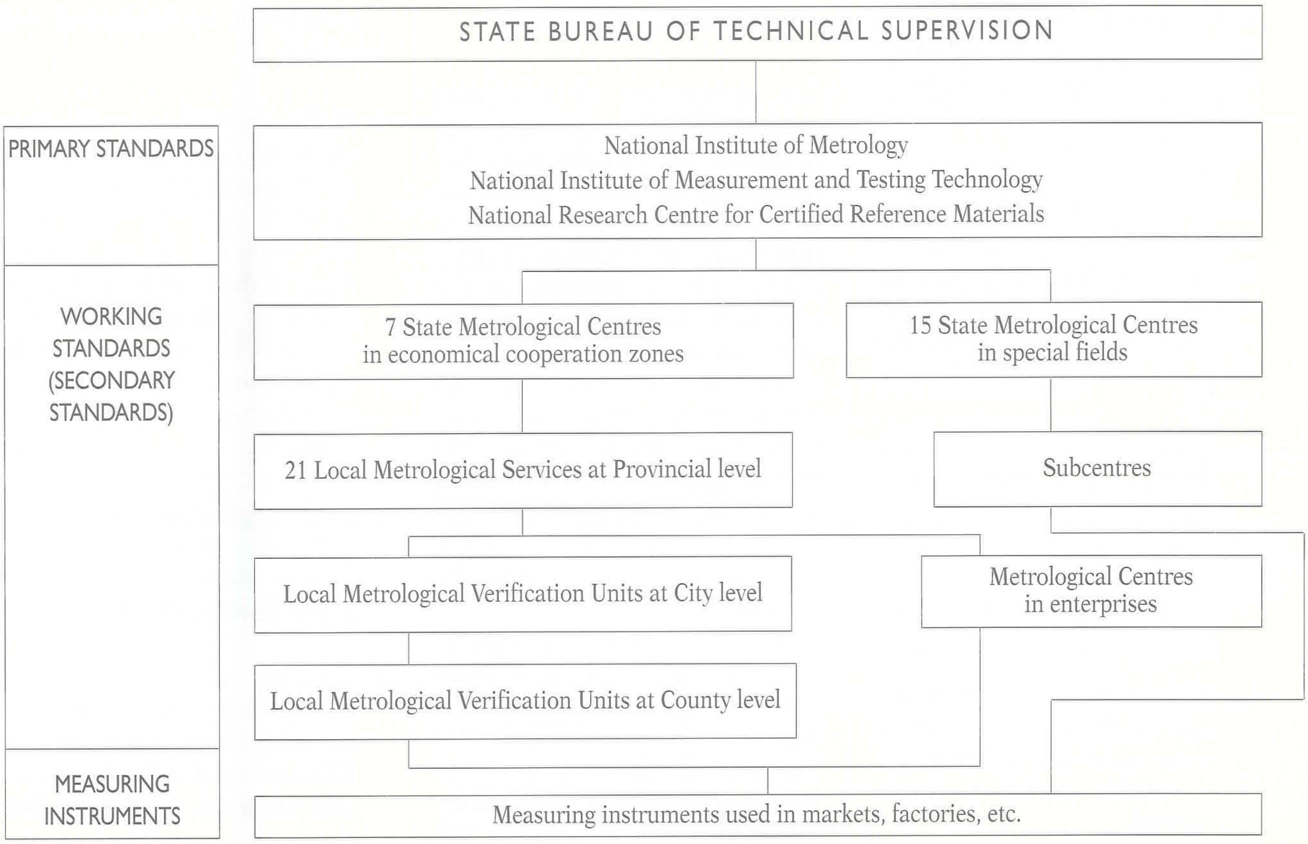


Fig. 2 The metrology traceability system of China.

3.1 Supervision of instrument manufacturers and foreign suppliers

It is required that new types of instruments pass the pattern approval before production and sale. It is the manufacturer's responsibility to apply for pattern approval to the Metrology Administrative Department (MAD) at provincial level. The authorized institute carries out the testing on the samples according to the designation by MAD. A conformity certificate of pattern approval is issued and announced to the public by MAD if the samples meet the requirements of the national regulation concerned. The manufacturer only needs to apply to MAD for samples examination if that type of instrument has been announced to the public by the MAD.

For some kinds of imported instruments, the foreign supplier (or his agency) must apply for pattern approval to CSBTS. The list of these kinds of instruments has been published by CSBTS with the approval of the State Council.
In addition, CSBTS will carry out periodic supervision on instruments which are for sale in the market in order to guarantee the quality of these instruments.

3.2 Market supervision

Metrology supervisors are responsible for market supervision in China. They must be trained, pass the examination and obtain the certificate issued by the CSBTS. Supervision mainly covers instruments used in the market, e.g. scales, gasoline dispensers and prepackaged goods. A standard concerning requirements on the weighing of retail goods has been promulgated by the Ministry of Domestic Trade and CSBTS. It specifies the accuracy of the instrument used and the individual and average deficiencies of goods. Requirements on the trade of massive raw materials will be published soon. In addition, a new standard (in which OIML R 79 and R 87 are adopted) for prepackaged goods will be issued in the near future. It includes the requirements for most of prepackaged goods.

3.3 Compulsory verification

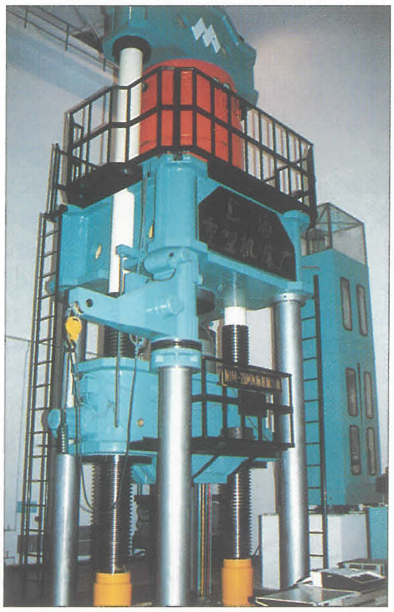
MAD has registered instruments subject to compulsory verification and conducted verification regularly under its jurisdiction. Anybody will be punished if he/she uses instruments which have not been verified and proved valid according to a stipulation of the *Rules for the implementation of the Law on Metrology of the People's Republic of China.*

There are 111 kinds of measuring instruments used for settling trade accounts, safety protection, medical treatment and environmental monitoring, and which are subject to compulsory verification. They are divided into three categories:

(1) Those that are simple in construction and easily broken, such as a ruler made of bamboo and wood, liquid-in-glass thermometer, etc. For these kinds of instruments, only initial verification is necessary.

(2) Those which are used on line such as electric energy meter, water meter and gas meter etc. A validity period is implemented.

(3) The rest are requested to be submitted to periodic verification in accordance with the relevant regulation.



The 20 MN force standard machine installed at NIM for testing load cells according to OIML R 60.

3.4 Metrology accreditation

The supervision of measuring results made by testing laboratories is carried out by Laboratory Accreditation in China, which we refer to as Metrology Accreditation; ISO Guide 25 has been adopted equivalently in principle as the criteria of accreditation. Assessments are carried out by assessors and experts concerned. These laboratories are divided into two levels: those that provide services only in the province are accredited by the MAD at the provincial level; others that provide services in the whole country are accredited by the CSBTS.

Metrology accreditation began in 1986 and nearly 1 100 laboratories affiliated with 30 Ministries have been accredited by CSBTS. Metrology accreditation has been very much appreciated by these Ministries. It improves the reliability and repeatability of test results and reduces disagreement between testing results.

4. OIML Conformity Certificates in China

The *OIML Certificate System for Measuring Instruments* was launched on 1991.01.01 and the CSBTS issued an announcement saying that the OIML Certificate System would be promoted in China in September 1991 with a document entitled "The procedure of promoting the OIML Certificate System in China". This document describes the issuing authority, the procedure for application, selection of the testing laboratories, sampling testing, issuing certificate and fee, etc. We combine the OIML Certificate System with pattern approval in China in order to accelerate the implementation of the OIML Certificate System.

In addition, we adopted several measures:

1. *Holding seminars to introduce the OIML Certificate System and Recommendations of concern to manufacturers.* We have held five seminars up to present; three of them focused on R 76, two on R 112 and R 113, and one on R 60. About 200 people representing more than 100 manufacturers attended the seminars.

2. *Publishing brochures and leaflets to introduce the OIML Certificate System.* More than 1 000 brochures have been sold.

3. *Selection of the laboratories responsible for testing.* Metrology accreditation is carried out in China using accreditation standards similar to those in the ISO Guide 25 series. We chose the laboratories capable of meeting the testing requirements of relevant International Recommendations and passing the assessment of metrology accreditation. Five laboratories have been chosen to carry out the tests according to R 60, R 76, R 112 and R 113.

Up to now, there have been 10 applicants for OIML certificates and four certificates have been issued. Three applicants failed because their samples did not meet the requirements of the International Recommendations concerned. The rest were rejected because their instruments were not covered by the OIML System.

In summary, the OIML Certificate System has a good perspective in China but it depends on the mutual recognition of OIML certificates throughout the world. This is one of the main tasks that should be paid more attention by OIML and its Member States. ■

WEIGHING TOWARDS THE FUTURE

Chinese weighing in development

OIML Seminar
WEIGHING TOWARDS THE YEAR 2000
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Abstract

This paper addresses the present situation in China concerning the development of weighing instruments such as electronic price-computing scales, truck scale weighbridges, railway track scales, belt weighers, crane scales and load cells. Electronic types of weighing instruments only amount to less than 3 % of the total number of instruments. The existing national regulations on metrological verification and State standards referring to OIML International Recommendations are listed. The main problems and trends of weighing metrology are also pointed out.

1 Introduction

Moses in Deuteronomy, one of the books of The Law, recorded the commandment over 3 000 years ago: *"Do not have two differing weights in your bag - one heavy, one light. Do not have two differing measures in your house - one large, one small. You must have accurate and honest weights and measures..."* and then the foundation of legal metrology was laid. The existing ancient weighing metrology in China can be traced back to the Chu Dynasty of the Warring States, 475-211 B.C., when the royal bronze lever of steelyard and the bronze ring weights with a wood lever of steelyard appeared.

Prior to 1960, weighing was based, as it has been for centuries, on well-known mechanical principles of beams, levers, pendulums and springs. However, the last 30 years have revolutionized weighing metrology and the way in which weighing results are used; a major revolution in electronic technology has completely altered the design of weighing instruments.

Nowadays in China, the most advanced automatic weighing instruments are used in the industrial and scientific fields almost simultaneously with the traditional lever scales. This is generally the case in developing countries where there is a striking contrast between modern electronic scales, in the minority, and classical mechanic scales in the majority.

2 The present situation of weighing metrology for scales

Customarily speaking in China, weighing instruments can be divided into two categories: scales and balances in general; most special accurate instruments belong to the category of balances, but in this paper, only the scales are involved.

According to recent statistics from a sample of 126 enterprises, progress on scales during the decade 1983-1992, is summarized in Table 1. The total output for 1992 comprises 90 % of commercial scales (excluding the huge number of steelyard for retail), and 10 % of industrial scales. Among the 47 352 pieces of annual output of electronic scales in 1992, 86 % is used for commercial applications and 14 % is used in industry. As implied by the figures in this Table, electronic commercial scales make up 2.0 % of the total output of commercial scales, and electronic industrial scales account for 2.8 % of the total output of industrial scales.

Electronic price-computing scales

More than 20 enterprises produce a total of about 35 thousand units and only six of them are capable of manufacturing a great number of units. Three manufacturers have passed the strict examination by SBTS for an OIML certificate of conformity.

Truck weighbridges

More than 50 enterprises annually produce a total of about 1 500 instruments with the weighing capacity of 10 t, 20 t, 50 t, 80 t and even up to 300 t. The strain gauge

Table 1 Decade progress on scales.

	1983	1992	Increase rate (%)
Total output value *(million RMB)*	200	1 130	465
Total output *(thousand units)*	1 216.8	2 262	86
Output of electronic scales *(units)*	150	47 352	315
Profit *(million RMB)*	38	63.8	68
Profits tax *(million RMB)*	49.4	122.2	147
Labor productivity *(RMB/person)*	5 998	8 738	45
Export value *(million USD)*	1	16.4	1 544

Table 2 First code name for classifying types of scales.

Classification	Code name
Bench scale	A
Platform scale	T
Ground weighbridge	S
Underground weighbridge	Z
Rail-weighbridge	G
Crane scale	O
Belt weigher	I
Hopper scale	L
Catch weigher	F
Special scale	H

based load cells used in the construction of truck weighbridges are generally compact enough with an average life span of 10 years. The mean time between failures of indicators that are used in a truck weighbridge reaches up to 20 000 hours.

Automatic and nonautomatic rail-weighbridges

About 15 enterprises can produce rail-weighbridges and eight of them are capable of manufacturing automatic rail-weighbridges (weighing in motion). Among the 2 000 rail-weighbridges that are in use all over the country, 320 are automatic with a motion speed of 15 km per hour. A pitless instrument functioning on curve has been developed recently for limited spaces.

Beltweighers

For the belt weigher, more than 30 enterprises annually produce more than 4 000 sets with an accuracy class of 0.5 in general and 0.15 for a few. In addition, the total output of 3 000 is available for the nuclear type of belt weigher with an accuracy of 1 or 2 %.

Crane scales

More than 20 enterprises annually produce 1 000 units of crane scales with a weighing capacity up to 30 t. Some users need the capacity of 80 t and some require a high temperature condition of 120~150 °C.

Under the policy of promoting the socialist market economy, many sorts of scales are locally produced at present. It is necessary to standardize the methods used to classify the various types of existing scales. Ten sorts of scales, excluding the steelyard and balance, are classified in Table 2.

In this Table, the code name in the right column forms the first character of the product type name of scale. The classification is more complex: in addition to the first code, there is a second code name depending on the type of mechanism for load transmission or transfer feature, and a third code name depending on the type of display.

3 Requirements for scales from the Law on Metrology and the Standardization Law

According to the Law on Metrology of the P. R. of China, which entered into force 1 July 1986, weighing instruments of any kind used in trade accounts, safety protection, medical treatment and health, and in environmental monitoring shall be subject to compulsory verification by the authorities responsible for legal metrology above county level.

This law is enacted to strengthen metrological supervision and management; to guarantee the uniformity of the national system of units of measurement and the reliability of the accuracy of the values of quantities; to contribute to the developments of production, trade and science and technology; to meet the needs of socialist modernization and construction; and to safeguard the interests of the State and the people.

Anyone or any entity engaged in metrological verification, manufacture, repair, marketing and use of weighing instruments shall abide by this law. Those weighing instruments which have not been submitted for the verification provided for by the regulations and those which have been checked as unqualified, shall not be used. Some examples of the national metrological verification regulations in the field of weighing metrology are:

- Body weigh scale
- Postal scale
- Weights
- Price-computing scale
- Static mechanical rail-weighbridge, etc.

These regulations basically refer to OIML International Recommendations, e.g. R 76 *Nonautomatic weighing instruments,* but sometimes certain relevant requirements are modified or released temporarily to suit the needs for the development of domestic-built scales. For instance, the crane scales by which goods are weighed in the quasi-static condition, are divided into two accuracy classes for which the MPEs can be somewhat greater than those specified in R 76.

Any enterprise or institution engaged in the manufacture or repair of weighing instruments shall have appropriate facilities, personnel and verification equipment, and may, after being proved as qualified by the authorities above county level, obtain the "License for Manufacture of Weighing Instruments" or "License for Repair of Weighing Instruments". Since 1986, about 230 manufacturers obtained such licenses for manufacture, and 110 of them manufacture electronic instruments.

Where any enterprise or institution manufactures new types of weighing instruments which have not been previously manufactured by themselves, the new types of weighing instruments may be put into production only after the metrological performance of specimens have been proved as qualified through technical evaluations organized by authorities above province level.

Imported weighing instruments may be marketed only after they have been verified or tested and found to meet the standard by the authorities above province level. Many kinds of foreign products have passed such verification or test.

The Standardization Law of the P. R. of China became effective 1 April 1989 and was formulated for the purpose of developing a socialist commodity economy, promoting technological progress, improving product quality, raising social economic efficiency, and safeguarding the interests of the country and people.

4 Development trends for weighing instruments

It seems to be a serious problem in China that more than 100 million sets of steelyards with lower accuracy are widely used in the countryside market, and consumer protection sometimes sustains losses. Initial efforts will be made to gradually eliminate a great deal of steelyards and reduce lever type mechanical scales. At the same time, it is necessary to promote the development of a more widespread application of electronic scales, dial spring mechanical scales and hybrid electromechanical scales.

According to the 8th Five-Year Plan, approximately 40 % of scale products are expected to be self-indicating and 11.4 % to be electronic. These figures imply that the annual output of electronic scales will reach 228 000 sets with corresponding numbers of load cells and indicators; this goal is difficult to attain from the standpoint of quality and quantity.

The function of the continuous totalisers (integrating scale) is to measure the flow-rate of bulk products by referring to dynamic weighing metrology, and the function of the weigh-feeders is to ensure a constant flow-rate of bulk products referring to dynamic proportioning metrology. There is a potential market demand for such dynamic metrology.

The OIML secretariats of China are promoting the *OIML Certificate System for Measuring Instruments,* beginning with weighing instruments based on the R 76-2 Pattern evaluation report. More than 10 scale manufacturers have applied for an OIML certificate of conformity for samples of scales, but up to now, only three companies with their electronic price-computing scales have passed. Implementation of this Certificate System will promote the improvement of scale quality and management, and especially the improvement of long-term stability and reliability of the load cell as the heart of electronic scales. ■

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DIMENSIONAL MEASUREMENT

Multiple dimension measuring devices

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Abstract

Canada and the United States of America are collaborating on the development of specifications applicable to devices that measure the size of objects for determining freight, shipping, postage or storage fees. These devices are referred to as multiple dimension measuring devices or as solid volume measuring machines.

Introduction

The shipping and air cargo industries are fast growing and are continuously looking for ways to increase productivity. This has prompted the industry to develop devices that process packages rapidly and with very little handling. In addition, determining appropriate pricing is always a concern.

In the past, pricing was based solely on the weight of parcels. Consequently, revenue was lost during the transport of goods that were large but weighed very little. When priced on the basis of weight, a large object with a low density (mass to volume ratio) does not generate much revenue although it occupies significant space in the cargo area. To overcome this, the shipping industry has developed ways of ensuring that losses are not incurred due to variability in the density of shipments.

The solution adopted by carriers is to charge for the space occupied by an object when it is light but large. Conversion factors were instituted to transpose the solid volume of an object into a "dimensional weight" value. By comparing the dimensional weight to the actual scale weight, the greater of the two becomes the basis for the charge. This approach has become increasingly popular and is setting the pace for the cargo industry.

History of OIML TC 7/SC 5

To address this new trade practice, Industry Canada's Legal Metrology Branch (LMB) proposed, in July 1992, the draft document *Ministerial Specifications on Solid Volume Measuring Devices - SGM-7*. Furthermore, testing procedures were developed and test standards were designed and built.

In May 1993, the National Conference on Weights and Measures (NCWM) formed a working group to develop technical requirements, tolerances and field test procedures for multiple dimension measuring devices.* Upon reaching a consensus for the final revision of the specifications, the Working Group recommendations were forwarded to the Specifications and Tolerances Committee of the NCWM. The conference members voted for the inclusion of these specifications into NIST Handbook 44 - *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices* at the National Conference of Weights and Measures' Annual Meeting in July 1995 (with a small modification).

In its efforts to harmonize any new requirements with those of the US, Canada has distributed the jointly developed specifications to the Canadian industry for comments and has undertaken the necessary measures for their legal adoption in Canada, thus replacing the draft SGM-7 document with the newly proposed specifications.

In Aug. 1993, the Australian National Standards Commission proposed to the *Organisation Internationale de Métrologie Légale (OIML)* the formation of a technical subcommittee to address multiple dimension measuring devices and volunteered to be its secretariat. Technical subcommittee TC 7/SC 5 was created and its secretariat was granted to Australia.

* *This working group was composed of manufacturers, users and regulatory officials. It was also charged with developing criteria to be used in the type evaluation of these devices under the National Type Evaluation Program (NTEP). NTEP is a program of the NCWM and is managed and administered by NIST.*

Ms. Dupuis-Désormeaux is the Technical Advisor for the USA National Conference of Weights and Measures - Multiple Dimension Measuring Devices Working Group.

Prior involvement by other countries

Based on information available to the author, the following describes prior involvement by other countries in the field of dimensional measurement.

The Norwegian Bureau of Weights and Measures, in conjunction with a private manufacturer, developed general performance criteria and testing procedures for multiple dimension measuring devices. In Norway, one such device received design approval in December 1987. The tests performed on this device were conducted by taking six readings of boxes ranging from 10 % to 90 % of the device's maximum capacity and by varying their orientation.

The German Bureau of Weights and Standards (Physikalisch-Technische Bundesanstalt, PTB) along with the same manufacturer involved in the Norwegian procedures, also developed performance criteria and testing procedures. The PTB tested the above manufacturer's device by using rectangular and pyramid shaped objects at different orientations and granted its approval in Feb. 1991 with the condition that, for every new installation, the device be verified such that it meets the conditions set forth in this approval.

Both the Norwegian and the German devices had to comply with marking and sealing requirements as well as with a tolerance of ± 1 cm (0.4") for any length (or the precision marked on the device). In addition, the PTB required that the minimum volume measured be 10 litres (0.35 ft^3).

Working group requirements

Extent of the application

Most countries have existing specifications for linear measures, such as tape measures or rulers; hence, the Working Group specifications only apply to automatic and semi-automatic devices and not to such manual devices. Devices equipped with a scale must comply with existing requirements for scales.

Other applications

Presently, the main applications for these devices are storage, postage, shipping and freight; however, other applications will be considered as long as the device is clearly appropriate for the task.

Proposed verification (checklist items)

The main areas assessed during verification are: intended application, digital indications, markings and sealing requirements.

Proposed testing

The testing section consists of: performance requirements (e.g., capacity range, accuracy and repeatability), susceptibility to disturbances and influence factors (e.g., power voltage variations, electromagnetic interferences and electrostatic discharges), susceptibility to surrounding conditions (e.g., temperature and humidity variations, acoustic and illumination interferences), and susceptibility to operation faults. The susceptibility tests evaluate the device's ability to either show no indication, show an error code, or continue to perform within tolerances during the interference and afterwards.

Tolerances

From the tolerances listed in Table 1 evolved the tolerances proposed by the Working Group, which are given in Table 2 *(see p. 32)*. The main difference between them is that the former are relative while the latter are absolute and are a function of the device's graduation size.

Both offer larger tolerances in the low range due to the difficulties encountered in measuring small objects. The first tolerances (Table 1) were developed in relation to worst case errors, i.e., those for which all axial errors are at their maximum and are additive. Thus the total volume error is the linear addition of the maximum individual length errors.

In contrast, the new tolerances assume a normal distribution of errors which uses a root sum square approach. Hence, for a total volume error of 15 %, the old requirements specify that the error on each length be no greater than 5 %; however, the new approach allows each linear error to be as great as 8.33 % (12 d) for the same total volume error.

Indications

Anyone familiar with weighing technologies may acknowledge that the zero indication of a scale can drift. However, with respect to technologies utilized in dimensioning, the zero may be defined by the absence of an object on the device's measuring element. Thus, prior to each measurement, the devices can indicate or record either: a zero or ready condition or an out-of-zero or non-ready condition. A zero or ready condition may be indicated by means other than a continuous digital zero, provided that any measuring operation is inhibited when the device is in an out-of-zero or non-ready condition.

Indication below minimum or above maximum

Since the throughput experienced by these devices is very high, it was decided that when the object is smaller than the minimum or

Table 1 Previous tolerances.

Volume tolerance is: $E = [e_x + e_y + e_z + (e_x e_y e_z)/10^4]$ %
Where E, $e_{x,y,z}$ are in percentages.

Length of Sides X,Y,Z	Length Tolerances $e_{x,y,z}$
0.0 < L < 10.0 cm	5.00 %
10.0 ≤ L < 30.0 cm	2.50 % + 0.25 cm
30.0 ≤ L < 100.0 cm	1.00 cm
100.0 cm ≤ L	1.00 %

Table 2 Newly proposed tolerances.

Increment size	**Tolerance**	**Min. length to be measured**
0 < d ≤ 1 cm (0 < d ≤ 0.5")	**± d**	12 d
1 cm < d ≤ 5 cm (0.5" < d ≤ 2")	**± d**	30 d
5 cm < d (2" < d)	**± d**	50 d

Where d is the minimum increment size displayed, corresponding to each direction.

larger than 105 % of the maximum dimensions marked on the device, the indicating or recording element shall either not display or record any values, or identify the display or recorded representation as an error.

Sealing

As with other systems, multiple dimension measuring devices may be designed with provisions for applying a tamper proof security seal, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), to prevent any change that might detrimentally affect the metrological integrity of the device.

Marking requirements

The manufacturer's identification (ID), the model designation, the serial number, the maximum and minimum dimensions for each axis, the value of the minimum increment size displayed (d), temperature limits (if other than -10 °C to +40 °C), minimum and maximum measuring speeds (if the technology used requires the object to be moved relative to the device), special application (if other than storage, postage, shipping or freight) and limitation of use (e.g., the device is restricted to cuboids) are to be marked on the device. An indication that the dimensions shown are those of the smallest rectangular box that would entirely enclose the object shall either be marked on, displayed or printed by the device.

Approach

Effect of the orientation of the object to be measured

There has been much debate regarding the significance of calculating the dimensions for the "smallest" box that would enclose the object being measured. This requirement seems unreasonable to some, who argue that when an object is measured by hand, the operator will not be able to readily detect the smallest box that would enclose it; thus, rendering the requirement more stringent for devices than for manual measurements.

Nonetheless, in order to have repeatable results for any orientation of an object being measured, it was decided that the dimensions shown would have to represent the smallest rectangular box that would entirely enclose it.

This can be explained by the following: when an object is a rectangular parallelepiped, regardless of its orientation, the projected dimensions will always yield the smallest box that would enclose it (i.e., its outer profile); the same can be said of right-angle triangles, pyramids and other homogeneous surfaces formed of acute or right angles. However, when an object includes an obtuse angle, the measurements are extremely orientation dependent and consequently, the costs may vary greatly due only to the orientation of the object on the measuring device.

Figures 1 through 4 show the variability that may occur due to the orientation of an object. For the same object, its projected volume for Fig. 1 is 128 871 cm^3, for Fig. 2 it is 116 122 cm^3, for Fig. 3 it is 93 788 cm^3 and for Fig. 4 it is 64 507 cm^3. The difference between the smallest and the largest projected volumes is nearly 100 %, simply due to the way it is positioned on the device.

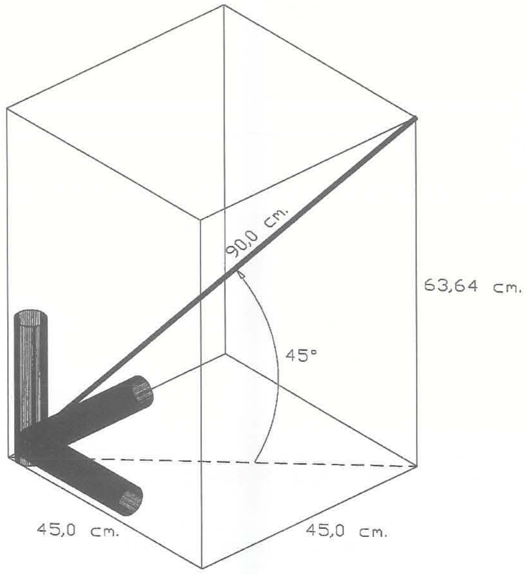


Fig. 1

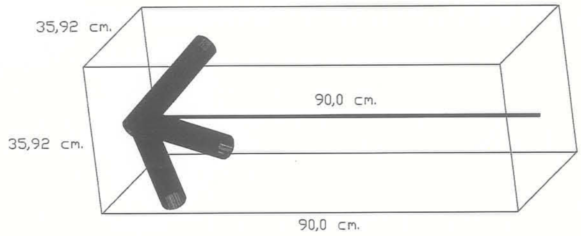


Fig. 2

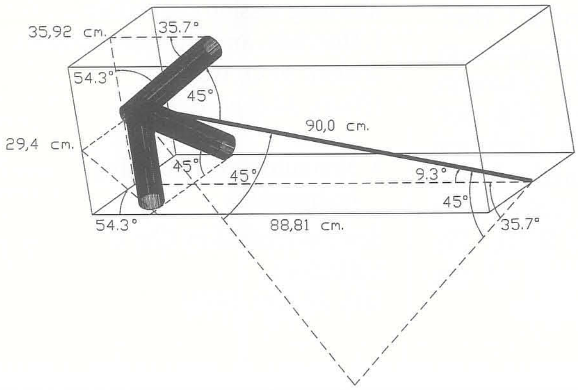


Fig. 3

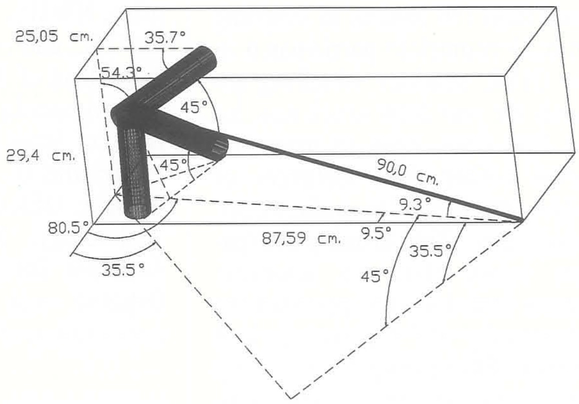


Fig. 4

Due to the high throughput of measuring operations, packages are likely to be oriented in countless ways; since positioning is critical, manufacturers need to specify device limits beyond which the smallest box can no longer be achieved. Such limits may be size, material or shape of object or any particular mode of operation that would prevent the device from yielding the required values.

Manufacturers may also choose to state the converse i.e., appropriate objects, orientations and procedures for which the device continues to measure correctly. Special applications where customers require that the objects be placed in a specific orientation should supersede the manufacturer's position requirements.

Summary

Significant contributions have been made by many countries in an effort to develop pertinent specifications for multiple dimension measuring devices. Unfortunately, these requirements may differ from one country to another. The formation of the OIML technical subcommittee TC 7/SC 5 will enable the creation of international recommendations that can be adhered to by all member countries, thereby enhancing the likelihood of equity in this important market. ■

activities
OIML
activités

OIML Seminar

WEIGHING TOWARDS THE YEAR 2000

13–15 September 1995 Maison de la Mécanique, Paris

More than 150 experts in weighing from 34 countries* participated in the OIML seminar *Weighing towards the year 2000* which was, for the first time, open to manufacturers (other than lecturers or representatives of manufacturers' federations). This broad participation (more than 65 scientific experts from industry) provided the opportunity for discussions and contacts for creating the necessary synergy in the weighing community and for making significant progress in OIML activity within the various technical committees and subcommittees.

The seminar was organized by OIML in collaboration with the *Comité Européen des Constructeurs d'Instruments de Pesage (CECIP)* and the *Syndicat du Pesage et du Comptage (France)*, and was held in the Auditorium of the *Maison de la Mécanique* in Paris La Défense, an important financial district just outside the western limits of Paris.

The 25 lectures that were presented during the two and half days were chosen by a Board of Selection headed by the Chairman of the seminar, S. Bennett, Chief Executive, NWML, and CIML Member for U.K., and composed of I. Hoerlein, Head of Trade Measurement, NSC, Australia; Chr. U. Volkmann, Head of Mass Division, PTB, Germany; and O. Warnlof, Technical Advisor, Office of Standards and Technology, NIST, U.S.A. The Assistant Director of BIML, Ph. Degavre, was in charge of the coordination of the seminar.

* *Australia, Austria, Belgium, Brazil, China, Cameroon, Canada, Czech Republic, Denmark, Ecuador, Finland, France, Ghana, Germany, Iceland, Indonesia, Italy, Japan, Kenya, Luxembourg, Netherlands, New Zealand, Norway, Poland, Rep. of Korea, Romania, Russian Federation, Slovenia, Spain, Sweden, Switzerland, U.K., U.S.A, Yugoslavia*

Seminar sessions

- **General topics related to weighing instruments**

Two sessions chaired by S. Bennett
(Wed. 13 Sept. 1995)

- **Automatic weighing instruments and weighing in motion (WIM) problems**

Morning session chaired by I. Hoerlein, and afternoon session chaired by O. Warnlof
(Thurs. 14 Sept. 1995)

- **Nonautomatic weighing instruments**

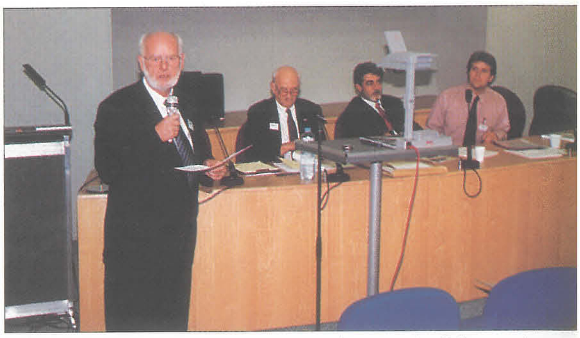
Session chaired by Chr. U. Volkmann
(Fri. 14 Sept. 1995)

General view of the delegates attending the *Weighing towards the year 2000* seminar, at the *Maison de la Mécanique*, Paris La Défense. More than 150 experts in weighing participated in the seminar.

Conclusions and acknowledgments

This seminar was a success due to the quality of the lectures and questions raised following each lecture. With the field of weighing being as large and diverse as it is, it was necessary to offer the seminar participants a range of topics of high interest to representatives of both government and industry.

BIML would like to express its appreciation to S. Bennett, Chairman of the seminar; the Board of Selection of the lectures; the different Chairmen for each session; CECIP and its President, W. Vanthienen; the *Syndicat du Pesage et du Comptage* and its President, Ch.-M. Gougé, for hosting the reception given in honor of this event, and its General Secretary, M. Turpain and his Assistant, P. Saint-Germain.



During the Thurs. afternoon session (Sept. 14) of the seminar. *From left to right: N. Dollerup (Denmark), O. Warnlof (U.S.A.), P. Arfos (France), and T. Myklebust (Norway).*

A word from the Chairman

The readers of this will hardly need to be reminded how important weighing is in our everyday lives. Whether you are shopping for food, visiting your doctor, sending a package by post or checking in your luggage for an international flight you will depend on accurate reliable weighing equipment to protect your health, your safety and your wallet.

The seminar *Weighing towards the year 2000* reflected the latest developments in weighing and demonstrated clearly the need for international metrological specifications in those applications where legal control is required to protect the consumer. With 25 papers presented by authors from 15 countries, it was possible in three days to cover the whole range of applications from shop scales to in-motion railway weighing: from grams to tonnes. It was particularly encouraging that approximately half those present were representatives of manufacturers of weighing equipment and it is to be hoped that OIML can continue to encourage this level of industrial participation.

I am particularly grateful to all the speakers, without whom there would have been no seminar. The standard of the papers was, in my view, uniformly high. I should also like to thank Ian Hoerlein, Christian Volkmann and Otto Warnlof who assisted with the selection of the papers, and also Philippe Degavre and the staff of BIML who so ably made all the preparations for an excellent seminar.

Seton Bennett

History of OIML technical seminars

Electronic devices incorporated in weighing and liquid and gas metering equipment
Borås, 21–25 September 1981
Hosted by the National Testing Institute of Sweden

Prepackaged products
Berne, 6–8 June 1983
Hosted by the Swiss Federal Office of Metrology

Testing of bulk weighing installations
Paris, 22–25 April 1985
Hosted by the French *Sous-Direction de la Métrologie*

Calibration of liquid volume measuring installations
Arles, 11–15 May 1987
Hosted by the French *Institut de Régulation et Automation (IRA)*

Weighing in Braunschweig
Braunschweig, 15–18 May 1990
Hosted by Physikalisch-Technische Bundesanstalt (PTB), Germany

Clean air measurement
Interlaken, 28 Sept–1 Oct 1992
Invited by the Swiss Federal Office of Metrology

WEIGHING TOWARDS THE YEAR 2000

Abstracts of the lectures presented at the OIML seminar on weighing

OIML Seminar WEIGHING TOWARDS THE YEAR 2000

13–15 September 1995 Maison de la Mécanique, Paris

Evolution of the US National Type Evaluation Program - Canada/US mutual recognition, OIML certification project

J. Truex, Weights & Measures, State of Ohio, U.S.A., and Chairman of the National Conference on Weights and Measures (NCWM)

This presentation briefly describes the evolution of the National Type Evaluation Program (NTEP) in the U.S. and its present situation. It also describes the sequence of events and the results of the negotiations between the U.S. and Canada in the development of the Memorandum of Understanding dealing with Mutual Recognition of Type Evaluations, its scope and conditions. The extent of U.S. participation in the OIML Certificate System is also covered. Most importantly, this presentation provides the necessary information to manufacturers of equipment as to how to fully utilize this program. It also conveys sufficient information to legal metrologists so that they can have every confidence that a type evaluation conducted in the U.S. is comparable to those conducted in the laboratories of Europe.

Chinese weighing in development

Shi Changyan and Ma Yanbing, National Institute of Metrology and State Bureau of Technical Supervision, China

This paper concerns the present Chinese situation concerning the development of weighing instruments such as electronic price-computing scales, truck scale weighbridges, railway track scales, belt-weighers, crane scales, and load cells. Electronic types of weighing instruments only amount to less than 3 % of the total number of instruments. The existing national regulations on metrological verification and State standards referring to OIML Recommendations are listed, and the main problems and trends of weighing metrology are also pointed out. *(This article is published on pp. 27–29.)*

Practical problems of using non-automatic weighing instruments in automatic process lines

Aimo Pusa, Raute Precision Oy, Finland

In the past few years the development of automatic control systems has been very effective. The control of machines and lines of different processes has been automatized in a way that could not be imagined 20 years ago. From the point of view of the construction engineer, the weighing instrument (automatic or not) is a part of the process line. A non-automatic weighing instrument (NAWI) is frequently used if the load stops on the load receptor during the weighing process and if the automatic control system replaces all the measurement functions of the operator. Otherwise, an automatic weighing instrument is used. The paper describes a practical situation (NAWI used in an automatic process line) and requests a clarification of the definitions of automatic and nonautomatic weighing instruments included in the terminology of the six OIML Recommendations dealing with weighing instruments.

Recommendations for automatic weighing instruments

L. M. Birdseye, National Weights and Measures Laboratory, U.K.

OIML TC 9/SC 2 has produced Recommendations on five classes of automatic weighing instruments: R 106 *Automatic rail-weighbridges* and R 107 *Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)*, published in 1993; and R 50 *Continuous totalizing automatic weighing instruments (belt weighers)*, R 51 *Automatic catch-weighing instruments*, and R 61 *Automatic gravimetric filling instruments*, which have recently been amended to reflect technical progress. Critical features of the work have included: classification of instruments, many methods of classifying accuracy and also, agreement on technical requirements. Each Recommendation is now supported by test procedures and a type evaluation report, documents which will enable a more transparent implementation of the requirements. The paper will also discuss some of the principal innovations introduced into the Recommendations.

Do we need six Recommendations for weighing instruments?

Chr. U. Volkmann, Physikalisch-Technische Bundesanstalt, Germany

There are many different kinds of automatic weighing instruments (AWI) for which metrological and technical requirements are laid down in five OIML Recommendations which overlap, to some extent, with OIML R 76. The functions of the different kinds of AWIs are categorized under some basic aspects such as weighing of discrete or continuous loads, separating discrete loads or weighing pre-assembled loads, and determining an individual or a totalized load. The metrological requirements for AWIs are analyzed in relation to their particular functions, the needs of the users or other parties concerned, the state of the art in weighing technology, the influence of other regulations, e.g. R 76 (NAWIs) and R 87 (prepackages).

Pattern approval and verification of weighing instruments constructed from modules

I. Hoerlein, National Standards Commission, Australia

The National Standards Commission has developed a system which allows the pattern approval and verification of weighing instruments constructed from modules. With the advent of electronic weighing instruments it has become practical to construct a variety of instruments from a wide range of modules such as load cells and digital indicators. The Commission's system enables these modules to be approved separately and various other certificates of approval to be issued, thereby allowing the modules to be combined into an instrument which may be verified in the field. *(This article was published in the OIML Bulletin, Vol. XXXVI, no. 4, October 1995, pp. 17–27.)*

Quality assurance systems applied by manufacturers - the implications for pattern approvals and initial verifications

B. J. Anthony, Avery Berkel, U.K.

The recent trend by all manufacturers towards the accreditation of quality systems, and the increasing demand from customers in both retail and industrial weighing sectors has seen many manufacturers adopt and implement international quality management systems - notably the ISO 9000 series. The benefits for their general business, closer control, increased efficiency and reduced costs have been more than sufficient to justify these moves. There are, however, additional benefits which have become apparent: many 'approval' organizations now operate different approval and monitoring regimes, and intrinsic safety is a prime example. The ability to self-declare conformity with EC Directives on such topics as low voltage safety, electromagnetic compatibility and machinery safety is enhanced by the existence of quality management systems. The principle and methods of pattern approval have changed little over the last century; the system of examination and testing was no doubt appropriate in the past, but it must be questioned as to whether it is right for the 21st century.

Elaboration of the new International Document OIML D 11

J. G. Tuinder, NMi, Netherlands

The revision of OIML D 11 has taken eight years, and not less than six drafts were elaborated in order to complete the new version which was distributed in 1995. In this paper, a comparison is made between the 1986 version and the new one. In the course of the years, a change in the appreciation of experts regarding the electronic instruments has occurred; this evolution has had an impact on the interpretation of OIML D 11, nowadays providing the experts the opportunity to use it as a guide rather than as a model list of requirements or direct applicable requirements. A chapter with a general approach to durability has been added, which must also be used as a guide by the technical committees and subcommittees that are drafting requirements on durability for specific electronic measuring instruments.

Traceable mass - Determination at capacities higher than 50 kg - Balance and mass standard requirements

A. Helms, Sartorius AG, Germany

In industrial and legal metrology, highly accurate heavy load instruments have become necessary because of the introduction of quality management systems on an internationally harmonized basis (ISO 9000, ISO/IEC Guide 25). Therefore, the calibration of high capacity scales requires more and more accurate mass standards. In order to calibrate those scales highly precise mass standards are also required as references. For this reason, an organized form of availability of higher capacity mass standards and especially traceability to the national 1 kg- mass-prototype is needed. The 50 kg- mass- standards defined in the OIML Recommendation R 111 play an important role as they are used as a basis for stepping up to the calibration of ton mass standards. The instruments required for traceable mass determination are more accurate than those utilized for common weighing operations in trade and industry. They are especially designed for the dissemination of the metric mass scale from 1 kg to 500 kg, 1 000 kg and higher.

Test of weights

H. Källgren and T. Myklebust, SP - Sweden and Norway

This lecture presents the work of the OIML Task Force Group (still informal) which is preparing test procedures for verifying the compliance of weights with the requirements stated in OIML R 111: calibration, surface roughness, magnetism, convection, and density. The methods to determine the magnetic properties of weights are described, as well as the problems related to magnetic fields, magnetic field gradients, magnetic susceptibility, and the magnetic interaction between mass comparators and weights.

Comparison of zero and calibration stability on beltweighers installed in long and short conveyors

P. Chase, Chase Technology Inc., U.S.A.

Changes in the zero value as a result of automatic zero-setting on a belt-weigher are examined over an extended operating period. Weekly material testing data are also included to compare the stability of the calibration on long and short conveyors carrying the same product stream. The long conveyor has a belt 142 meters in length and the short belt is 36 meters in length. Data are available for a period of several years. The effect of varying time intervals between zero-setting is illustrated for times ranging from about one hour to 12 hours.

Practical experiences of in-motion railway scales

R. Savolainen, Pivotex Oy, Finland

The development of railway traffic and the growing need for more effective and flexible activities have risen among railway companies, and industry has taken great interest in in-motion railway weighing. Metrological regulations concerning in-motion railway weighing were unharmonized for a long time in different countries. The OIML Recommendation R 106 has now created a good basis for defining the accuracy classes and other features of the scales, as well as for specifying the verification testing methods.

Railway coupled wagon weighing in motion

K. Kacprzak, Central Office of Measures, Poland

In spite of significant progress in the reduction of weighing errors, accuracy of weighing in motion has still been a basic problem. The weighbridge is only one part of the surveying system which consists of coupled wagons (the train), that move with a certain velocity. The results of weighing depend, to an essential degree, on the technical state of the wagons, inter-wagon couplings, train velocity and its alteration during weighing, and track rigidity. The efforts that have been made lately to increase the accuracy of coupled wagons dynamic weighing, include the establishment of weighing conditions under which the highest accuracy can be reached, and the improvement of weighbridge design to compensate for errors resulting from external factors. On the basis of verification results analyzed from more then 50 weighbridges for coupled wagons weighed in motion for over 10 years in Poland, the weighbridges are divided into three accuracy classes: 0.2 A, 0.2 B, and 0.5. Weighbridges in classes 0.2 A and 0.2 B can be used for commercial purposes; weighbridges of class 0.5 are used for diagnosis purposes and not allowed for commercial purposes.

Slow speed weigh-in-motion, how it has evolved and why

L. F. Gorman, L. F. Gorman Associates, U.K.

A brief description is given for the essential components of weigh in motion systems and the various types of equipment that are available, their characteristics, their uses and the performance that can be expected from each of these different devices. The main body of the paper will concentrate on just one type of weigh in motion equipment that is in use today, the slow speed weigh in motion system. Fundamental differences of specifying machine criteria for automatic weigh in motion, and non automatic weighing equipment when considering approval requirements will be examined. The environmental requirements for successful verification of slow speed weigh in motion systems are considered, along with verification procedures. Should the verification result obviate the necessity to lay down specific site specifications? Many new trade weighing applications are now possible with the advent of approved automatic weigh in motion equipment. In addition many well established weighing requirements will enjoy a lowered cost of equipment to meet their needs. Benefits that trade-approved weigh in motion equipment will provide to industry, commerce, the consumer and the environment will be summarized.

Automatic weighing of axles - The Danish Way

N. Dollerup, Road Directorate, Ministry of Transport, Denmark

Ten percent of the Danish car population, the lorries, is responsible for 90 % of Danish road wear. It is therefore very important to have a thorough knowledge of the influences these vehicles have on the wearing of roads. This knowledge is also important when calculating the dimensions of bridges and roads, and is applicable to the planning of road maintenance. This encouraged the Road Directorate to buy its first scale in 1966, and later to develop its own scale. The paper describes recent WIM systems which enable the Road Directorate to make rough estimates of road wear.

Low speed weigh-in-motion system using a portable axle weigher

P. Arfos, Captels Weighing, France

This paper introduces a portable axle weigher which enables vehicles to be weighed statically or at low speed. The capacity is 20 t per axle at a permitted speed between 0 and 16 km/h (10 mph). The accuracy of the system is 20 kg per axle in a static mode and better than 3 % of the total weight when weighing in motion. In order to improve the performances of weighing in motion, CAPTELS worked three years in areas such as vehicle dynamics, frequency analysis, neural networks.

Approval of automatic weighing instruments for road vehicles (WIM)

T. Myklebust, National Measurement Service, Norway

This paper deals with automatic weighing instruments for road vehicles, and evaluates different influences on such instruments. The OIML Recommendation for automatic rail weighbridges R 106 is mentioned as well as how this Recommendation is applied for road vehicles. Test methods and the results from pattern approval tests of a class 2.0 instrument are also described.

Authorized WIM installations in Romania

S. Popovici and O. Borozan, Irmex SRL and Microinf SRL, Romania

This paper presents the studies and realizations of the authors in the field of WIM for trains and trucks. The equipment is tested and approved against OIML R 106 requirements, if appropriate; the performances that can be achieved are: class 0.2 for the total weight of a train at a maximum speed of 10 km/h, and class 2 for trucks at a speed up to 4 km/h. Special attention is paid to the plane distortions in the approaching zones, and proposals are made for including such requirements in OIML R 106.

Applications and designs of multiple dimension measuring instruments

B. J. Stringer, Quantronix, Inc., U.S.A

Many years ago, carriers in the shipping industry came to the conclusion that shipping rates based on weight alone was not equitable. Volume was also a necessary factor so that all shippers paid their fair share. When the cost of shipping was based on weight alone, to ship a 500 cubic decimeter box containing load cells for example, would cost significantly more than shipping the same two cubic decimeter box filled with only a PC board and foam protective material. In many instances the cost to the carrier were the same.

Over the past 20 years six basic technologies have been used experimentally. The three that have evolved and are in use today are infrared, ultrasonic, and laser. These are usually combined with a weighing instrument; to be fully efficient, they are incorporated into a conveyor system. Each of these technologies has different characteristics. A legal metrology regulation that includes metrological and technical requirements and test procedures must recognize all three. The maximum permissible errors established should be equitable to both carriers and shippers, and test procedures should simulate, as near as practicable, service conditions of operation.

The influence of OIML Recommendations on weighing instruments in China

Ma Yanbing and Yan Baozhu,
State Bureau and Qing Dao Bureau of Technical Supervision, China

This paper describes the influence of OIML International Recommendations on weighing instruments such as nonautomatic weighing instruments and load cells, etc. The authors analyze the differences between the national regulations and the OIML International Recommendations, and discuss the suitability and compatibility of these Recommendations in China; they also explain how to implement the OIML Certificate System for promoting the quality of weighing products as well as international trade.

Experience in development and mastering of electronic balance production

Yu. V. Tarbeyev and A. G. Korobkin,
D. I. Mendeleyev Institute for Metrology and the Stock-Holding Company MASSA, Russian Federation

At present, there is a great need for electronic balances for trade, medicine and industry in Russia. One of the main requirements of the Russian market for balances is their low cost, but with relatively high technical parameters. The stock-holding company "Massa" is the largest manufacturer of these types of electronic balances in Russia. The main product of the company is the tensometric balance with a load up to 30 kg. The company develops its balances taking into account the option of full automatic adjustment (including the temperature corrections of strain-gauge transducers) which makes it possible to reduce the balance cost retaining its high technical characteristics.

Software interfaces and requirements for freeprogrammable nonautomatic weighing instruments

R. Schwartz, Physikalisch-Technische Bundesanstalt, Germany

The modern weighing technology is characterized by great strides thanks to microelectronics and data processing. The trend leads from compact instruments to weighing systems with computer-controlled data acquisition and analysis combined with check and control functions. Today, suitable interfaces for data exchange enable weighing instruments to be integrated into networks such as commodity management systems or production management systems. This paper is intended to present a new approach within the European Community towards a harmonization of software requirements and software examination of freeprogrammable nonautomatic weighing instruments and peripheral devices. *(This article is published on pp. 10–14.)*

Zero drift - Calculating zero drift errors for class III strain gage based weighing instruments

G. J. Lameris, Hobart Corporation, U.S.A.

Electronic hardware methods for zero-tracking and zero adjustment cannot be disabled during a performance test of a weighing instrument. These methods include chopper stabilized amplifiers and ac driven modulators and demodulator. Any weighing errors in service caused by zero offset are far less today than ever before. Therefore, if type evaluation tests conducted by legal metrology are to determine the appropriateness of a design for accurate weighing in use, zero-tracking should be operational.

Reflections on nonautomatic weighing instruments' module "Load Cells"

B. Meißner, Physikalisch-Technische Bundesanstalt, Germany

The OIML Recommendation R 60 for the module "Load cell" (LC) has been developed before and partly parallel to the Recommendation R 76 "NAWIs". The R 60 deals with requirements and procedures for one LC, one capacity and at least also for only one partial range smaller than the maximum capacity. In practice, PTB provides "wide range LC-module-reports" for type series with different capacities and different accuracy classes. It is shown how to use documentation of the construction, data sheets, manufacturer results and certifications of the manufacturer. The highest reliability will be gained with an intercomparison measurement by the manufacturer and the national metrological service. Remaining differences between R 60 and R 76 will be pointed out, and additional requirements and further classifications regarding R 76 are described.

New facilities for testing load cells in the measurement range from 10 kg up to 50 t

J. A. Robles, Centro Español de Metrologia, Spain

The new facilities of the Centro Español de Metrologia (CEM) for testing load cells consist of a set of three deadweight force machines of 1 kN, 20 kN and 500 kN of nominal loads that allow a force ranging from 10 N up to 500 kN to be generated, both in tension and compression. This paper describes their technical and metrological characteristics and some details of their set up.

A compilation of the integral texts of the seminar lectures is available for 500 FRF (free for OIML Members). Please contact the International Bureau of Legal Metrology to request a copy:

BIML
11, rue Turgot
75009 Paris

Fax: (33-1) 42 82 17 27

METROLOGICAL ACTIVITIES IN DEVELOPING COUNTRIES

23–24 OCTOBER 1995
BEIJING, PEOPLE'S REPUBLIC OF CHINA

The OIML international symposium on *Metrological activities in developing countries* was organized within the framework of the Development Council in collaboration with the China State Bureau of Technical Supervision (CSBTS) and national metrology institutions of OIML members. Its objective was to address general policy issues concerning legal metrology, and cooperation and technical assistance at national, regional and international levels.

The symposium was attended by more than 100 participants from 43 OIML Member Countries, Corresponding Members, representatives of regional and international organizations: IMEKO, APLMF, WELMEC, SIM, CIMET.

Opening addresses were delivered by Xu Penghang, Vice-Minister of the State Commission of Economy and Trade; Li Chuanqing, Director General of CSBTS; and President of CIML, G. J. Faber. The symposium was chaired by Prof. M. Kochsiek, Vice-President of CIML and M. Benkirane, President of the Development Council.

Four sessions addressed a wide range of topics of interest to developing countries

After a presentation of the metrology system in the P. Rep. of China by Dai Runsheng, Head of the Chinese Secretariat for OIML *(see pp. 22–26)*, the symposium proceeded with four sessions: *Metrological policy issues; National metrology services; Cooperation in metrology at national, regional and international levels;* and *General legal metrology topics.*

The first session consisted of lectures by B. Athané, Director of BIML: *OIML policy and strategy* and Prof. Dr M. Kochsiek: *Accreditation of national metrology laboratories.*

The second session comprised ten presentations which concerned the organization and development of metrological systems at national level, and which were given by speakers from Belarus, India, Mauritius, Mongolia, Vietnam, Slovakia, Rep. of Korea, and Russia.

The third session was represented by five lectures concerning metrological cooperation at regional and international levels in the Asia-Pacific, Europe, and in the Inter-American System, given respectively by J. Birch, CIML Member for Australia, and Chairman of APLMF; S. Bennett, CIML Member for the U.K., and Chairman of WELMEC; J. F. Magana, CIML Member for France; S. Chappell, CIML Member for the U.S.A., and Vice-President of CIML. E. Seiler, Chairman of IMEKO TC 11, presented a lecture concerning the strengthening of legal metrology in developing countries.

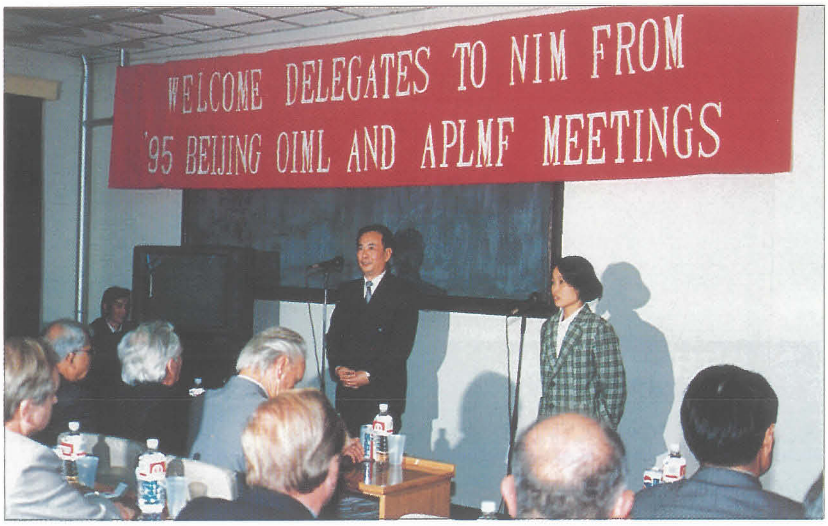
Session four included four lectures concerning traceability and standards, training requirements in legal metrology, and the utilization of general metrology laboratories for legal metrology purposes.

Dr M. Kochsiek, Vice-President of CIML, addresses delegates during the OIML symposium.

Opening of the OIML symposium on *Metrological activities in developing countries (from left to right):* M. Benkirane, President of the OIML Development Council; G. J. Faber, CIML President; Li Chuanqing, Director General of CSBTS; Xu Penghang, Vice-Minister of the State Commission of Economy and Trade; M. Kochsiek, CIML Vice-President; B. Athané, Director of BIML; Li Rui; and A. Vichenkov, Assistant Director of BIML.

Global harmonization: an important key to development

The presentations and lectures demonstrated that legal metrology is an important part of economic and industrial development. Much more is needed to be done in support of implementing legal metrology for the purpose of development, particularly the worldwide harmonization of legal metrology requirements and procedures through OIML Recommendations and Documents, and developing means for mutual confidence among OIML Members. ■



A visit to the Beijing National Institute of Metrology (NIM) was organized by CSBTS, giving delegates the opportunity to visit metrology laboratories and to acquire information on Chinese metrological activities and cooperation with various organizations.

METROLOGICAL ACTIVITIES IN DEVELOPING COUNTRIES

Recommendations for future action in favor of development

- Efforts should be made by all OIML Members to further develop and strengthen national legal metrology services and their harmonization so as to ensure measurement credibility for guaranteeing fair trade, required quality of products and services, and protecting society in health, safety and environmental spheres.

- The symposium calls on the OIML, national services and regional organizations concerned to provide assistance and all information to Government authorities in developing countries in order to clearly define their policies and obtain support for active participation of national services in OIML cooperation.

- The symposium calls on the OIML developing member countries in various regions to make efforts to promote regional cooperation, and to align regional legal metrology requirements with OIML international requirements and procedures.

- The symposium recognized the advantages of the *OIML Certificate System for Measuring Instruments* and recommends OIML members to take steps to adopt the System and support the establishment of mechanisms for mutual recognition of OIML certificates and acceptance of test results.

- The symposium requests the OIML Development Council and BIML to maintain liaisons with national, regional and international institutions and keep developing countries informed as to all technical and financial support that may be available concerning training courses and seminars, manuals, brochures, and documents on establishing metrology laboratories, and other aspects of legal metrology in developing countries and countries restructuring their national metrology services.

- The symposium recommends further promoting the organization of OIML symposiums and seminars on OIML policy issues, economical and industrial impact of legal metrology, regional and international cooperation, and legal metrology matters of specific interest for developing countries. Priority should be given to symposiums and seminars that facilitate interaction between Development Council members and international, regional and national development assistance agencies, as well as international economic institutions such as the World Bank, WTO, UNIDO and others, for the organization of symposiums and seminars on metrology in developing countries.

activities OIML activités **MEETINGS**

INTERNATIONAL COMMITTEE OF LEGAL METROLOGY

The International Committee of Legal Metrology held its 30th meeting 25–27 Oct. 1995, which was hosted by the Chinese State Bureau of Technical Supervision in the conference rooms of the Beijing International Convention Center.

Participation: More than 80 people, representing 41 of the 54 OIML Member States, participated in the meeting.

Mr Wu Bangguo, Vice-Prime Minister of the P. Rep. of China, honored CIML by opening the meeting. Mr G. J. Faber then presided over the discussions which led the Committee in making a certain number of important decisions for the future of OIML.

Main points

- Approval of four new or revised International Recommendations or annexes to existing Recommendations: R 51 *Automatic catchweighing instruments*, R 61 *Automatic gravimetric filling instruments*, Annexes (Test procedures and test report format) to R 106 *Automatic rail-weighbridges*, and R 123 *Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants*.

- Extension of the application of the OIML Certificate System to include automatic catchweighing instruments (R 51), automatic gravimetric filling instruments (R 61), portable and transportable X-ray fluorescence spectrometers (R 123), automatic rail-weighbridges (R 106), and pure-tone audiometers (R 104). The application of OIML certification to these categories becomes effective as soon as the following is published: OIML Recommendations R 51, R 61 and R 123, Annexes (test procedures and test report format) to R 106, and the Annex (test report format) to R 104.

- Acceptance of a number of work topics for the technical advisory group charged with the development of the OIML Certificate System (TAG_{cert}), which is expected to appoint Rapporteurs for each topic and to hold a meeting in 1996.

- Support for activities in favor of developing countries such as training workshops and seminars, circulation of relevant information, and use of new media for information and training, e.g. on-line databases, CD-ROM, and interactive CD-ROM. The Committee expressed its appreciation to M. Benkirane (Morocco), immediate Past President of the OIML Development Council, and noted the election of G. M. Putera, CIML Member for Indonesia, as President of the Development Council for the period 1995–1997.

Mr Wu Bangguo, Vice-Prime Minister of the P. Rep. of China, honored CIML by opening its 30th meeting. Pictured here with CIML and Chinese dignitaries. *From left to right:* B. Athané, S. Chappell, M. Kochsiek, K. Birkeland, G. J. Faber, Wu Bangguo, Xu Penghang, Li Chuanqing, and Li Dai.

➾ Revision of the general policy governing liaisons between OIML and regional legal metrology organizations, and re-examination of the relations with ILAC. The Presidential Council should examine these matters during its meeting in Feb. 1996.

➾ Appreciation for two important OIML events: the seminar *Weighing towards the year 2000*, Paris, 13–15 September 1995, chaired by Dr S. Bennett, CIML Member for the U.K. *(see pp. 34–35)*, and the OIML symposium on *Metrological activities in developing countries*, Beijing, 23–24 October 1995, chaired by Dr M. Kochsiek, Vice-President of CIML, Germany *(see pp. 40–41)*.

➾ Discussion on a rapprochement or fusion with the *Bureau International des Poids et Mesures*. The Committee requested its President, G. J. Faber, together with the President of the *Comité International des Poids et Mesures*, to appoint a joint working party to discuss this matter. Mr Faber will report to CIML on the progress of discussions for decision on further action during the next meeting.

➾ Dr S. Bennett chaired the round table on *Confidence in type approval* which was organized in conjunction with the CIML meeting, on Thur. 26 Oct.1995 *(see report pp. 20–21)*. The discussions were very interesting and the wish was expressed to hold similar round tables on important issues in the future.

➾ The Committee renewed the contract of B. Athané, Director of BIML, for a five-year period starting on 1 Jan. 1996, and extended the contract of A. Vichenkov, Assistant Director, for an 18-month period (until 30 Nov. 1997).

During the opening session of the 30th CIML meeting. *From left to right:* K. Birkeland, Xu Penghang, Wu Bangguo, G. J. Faber, Li Chuanqing and B. Athané.

➾ The Committee noted information pertaining to the preparation of the Tenth Conference and the 31st CIML meeting 4–8 Nov. 1996 in Vancouver, Canada, and decided to accept invitations from the delegations of Brazil and the Rep. of Korea to hold the 32nd CIML meeting in Oct.-Nov. 1997 in Rio de Janeiro, and the 33rd CIML meeting in Oct.–Nov. 1998 in Seoul. In 1999, it may be necessary to hold a CIML or Conference meeting in Paris in conjunction with the CGPM, for possibly examining the progress of the discussions on the BIPM/OIML rapprochement.

➾ Two receptions were attended by CIML delegates, their spouses, and several Chinese Authorities. A nice gift was offered to BIML by the Chinese Authorities: an OIML E_1 weight made and certified in China. BIML expresses its appreciation to Mr Li Chuanqing, CIML Member for P. Rep. of China, and to the staff of the State Bureau of Technical Supervision and the National Metrology Institute for their excellent organization of these meetings and events.

COMITE INTERNATIONAL DE METROLOGIE LEGALE

Le Comité International de Métrologie Légale a tenu sa 30e réunion du 25 au 27 octobre 1995, sur invitation du Bureau d'Etat chinois de Supervision Technique, dans les locaux du *Beijing International Convention Center* en Chine.

Participation: plus de 80 personnes représentant 41 des 54 Etats Membres de l'OIML ont participé à cette réunion.

Monsieur Wu Bangguo, Vice-Premier Ministre de la Rép. Pop. de Chine, a honoré le CIML en ouvrant la réunion. Monsieur G.J. Faber a ensuite présidé les débats qui ont permis au Comité de prendre un certain nombre de décisions importantes pour l'avenir de l'OIML.

Points principaux

➾ Approbation de quatre Recommandations Internationales nouvelles ou révisées, ou d'Annexes à des Recomman-

Le Président du CIML, G.J. Faber, évoque les futures orientations de l'OIML lors de son allocution d'ouverture pour la 30e réunion du CIML à Pékin, du 25 au 27 octobre 1995.

dations existantes: R 51 *Instruments trieurs-étiqueteurs à fonctionnement automatique*, R 61 *Doseuses pondérales à fonctionnement automatique*, Annexes (Procédures d'essai et format du rapport d'essai) à la R 106 *Ponts-bascules ferroviaires à fonctionnement automatique*, et R 123 *Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux.*

⇨ Extension de l'application du Système de Certificats OIML aux instruments suivants: trieurs-étiqueteurs à fonctionnement automatique (R 51), doseuses pondérales à fonctionnement automatique (R 61), spectromètres à fluorescence de rayons X portatifs et déplaçables (R 123), ponts-bascules ferroviaires à fonctionnement automatique (R 106) et audiomètres à sons purs (R 104). L'application de la certification OIML à ces catégories d'instruments deviendra effective dès la publication de ce qui suit: les Recommandations OIML R 51, R 61 et R 123, les Annexes sur les procédures d'essai et format du rapport d'essai pour la R 106, et l'Annexe sur le format du rapport d'essai pour la R 104.

⇨ Acceptation d'un certain nombre de sujets de travail du groupe technique consultatif chargé du développement du Système de Certificats OIML (TAG_{cert}), qui devra nommer des rapporteurs pour chacun des sujets et tiendra une réunion en 1996.

⇨ Soutien des activités en faveur des pays en développement telles que des cours de formation et séminaires, diffusion des informations appropriées et utilisation des nouveaux moyens d'information et d'enseignement, par exemple les bases de données en ligne, CD-ROM et CD-ROM interactifs. Le Comité exprime son appréciation à M. Benkirane, Maroc, dernier Président du Conseil de Développement de l'OIML, et prend note de l'élection de G.M. Putera, Membre du CIML pour l'Indonésie, comme Président du Conseil de Développement pour la période 1995–1997.

⇨ Révision de la politique générale régissant les liaisons entre l'OIML et les organisations régionales de métrologie légale et réexamen des relations avec ILAC. Le Conseil de Présidence devra examiner ces sujets pendant sa réunion en février 1996.

⇨ Appréciation sur deux événements OIML importants: le séminaire *Pesage vers l'an 2000*, Paris, 13–15 septembre 1995, présidé par Dr S. Bennett, Membre du CIML pour le Royaume-Uni *(voir pp. 34–35)*, et le symposium OIML sur les *Activités métrologiques dans les pays en développement*, Pékin, les 23 et 24 octobre 1995, présidé par Dr M. Kochsiek, Vice-Président du CIML, Allemagne *(voir pp. 40–41)*.

⇨ Discussion sur un rapprochement ou une fusion avec le Bureau International des Poids et Mesures. Le Comité a décidé de demander à son Président, Monsieur G.J. Faber, avec le Président du Comité International des Poids et Mesures, de désigner un groupe de travail commun pour étudier cette question. Monsieur Faber fera rapport au CIML du progrès des discussions en vue des décisions à prendre, pendant la prochaine réunion, sur les futures actions.

⇨ Dr S. Bennett a présidé la table ronde sur la *Confiance dans les approbations de modèle*, qui a été organisée en liaison avec la réunion du CIML le matin du jeudi 26 octobre 1995 *(voir rapport pp. 20–21)*. Les débats ont été très intéressants et il a été souhaité que des tables rondes du même genre, relatives à des sujets importants, soient organisées à l'avenir.

⇨ Le Comité a renouvelé le contrat de B. Athané, Directeur du BIML, pour une période de 5 ans à compter du 1er janvier 1996 et a prolongé le contrat de A. Vichenkov, Adjoint au Directeur, pour une période de 18 mois (jusqu'au 30 novembre 1997).

⇨ Le Comité a également pris note des informations relatives à la préparation de la Dixième Conférence et de la 31e réunion du CIML, à Vancouver, Canada, du 4 au 8 novembre 1996, et a décidé d'accepter les invitations des délégations du Brésil et de la Rép. de Corée à tenir la 32e réunion du CIML, en octobre ou novembre 1997, à Rio de Janeiro, et la 33e réunion du CIML, en octobre ou novembre 1998, à Séoul. Le Comité a pris note du fait qu'il serait nécessaire de tenir une réunion du CIML ou de la Conférence en 1999 à Paris, en liaison avec la CGPM, en vue d'un examen éventuel du progrès des discussions sur le rapprochement ou la fusion BIPM/OIML.

➯ Deux réceptions ont rassemblé tous les participants à la réunion du CIML, leurs conjoints et plusieurs Personnalités chinoises. Les autorités chinoises ont offert un beau cadeau au BIML: un poids OIML de classe E_1 fabriqué et certifié en Chine. Le BIML remercie Li Chuanqing, Membre du CIML pour la Rép. Pop. de Chine ainsi que le personnel du Bureau d'Etat de Supervision Technique et l'Institut National de Métrologie pour l'excellente organisation de ces réunions et événements.

DEVELOPMENT COUNCIL

The OIML Development Council met in Beijing on 25 Oct. 1995 in liaison with the OIML symposium on *Metrological activities in developing countries* and the 30th CIML meeting.

Chairman: M. Benkirane (Morocco), President of the Development Council, with G. J. Faber, President of CIML, and B. Athané, Director of BIML.

Participation: 80 delegates and observers from 43 OIML Member States and Corresponding Members, representatives of international, regional and specialized organizations: IMEKO, APLMF, WELMEC and DAM. Reports for the meeting were received from ISO/DEVCO, ARSO and CIMET.

Main points

➯ The agenda contained the following main items:

- BIML report on activities of the Council since its last meeting in October 1994
- Discussion concerning evaluation of the OIML symposium on *Metrological activities in developing countries,* held 23–24 October 1995
- Guidelines for the Council's future activities, including training and certification
- Election of the President for the Development Council

➯ A report by BIML on the realization of the work program in 1994–1995 was presented to the Council. It was noted that according to the *OIML long-term policy* and *General information brochure,* both published in 1995, a high priority was given to development activity. The publication of these two documents constitutes a substantial support to metrological activity by demonstrating the role and tasks of international metrology cooperation to governmental authorities and national metrology bodies in developing countries. The report provided information on cooperation at regional and international levels, including OIML liaisons with IMEKO, ISO, UNIDO, APLMF, UN/ECE, ARSO, CIMET and other organizations.

➯ A number of training courses and seminars were organized during the 1994-95 period in cooperation with liaison institutions:

- Training workshop on *Volume determination of fixed storage tanks* by PTB/DAM, held in July 1995 in Germany with OIML participation. Some 20 representatives from various developing and transition countries were selected for the workshop.
- Training seminar *Metrology serving economic development* for representatives of countries in transition to market economy, held in March 1995 in Paris, France, jointly organized by UN/ECE, OIML and French metrology institu-

M. Benkirane (Morocco) chaired the last Development Council meeting of his mandate as President from 1988 to 1995. *From left to right:* G. J. Faber, CIML President; M. Benkirane; A. Vichenkov, Assistant Director of BIML; and B. Athané, Director of BIML.

tions. The seminar was attended by 15 specialists. Speakers were invited from European countries, USA, BIML and regional organizations: WELMEC, EUROMET, EAL.

- An expert group meeting on Quality, Standardization and Metrology co-sponsored by CSBTS and UNIDO was held in Beijing in April 1995, and a lecture on OIML activity was given by the Director of BIML.
- An annual course on legal metrology was given in Cuba in Oct. 1995, and a number of trainees from Latin American countries were sponsored by the Cuban Office for Standards.

⇨ Activities of the Council's working group on training in metrology were reported by the convener of the group, Dr Wallerus, DAM, Germany. A questionnaire was sent to the members of the group with a view to obtaining information and proposals concerning the organization of training, exchanges of relevant information and documentation, and the utilization of new electronic media such as electronic mail and CD ROM. An international workshop on "Checking of net content of prepackages" was scheduled by PTB/DAM in cooperation with OIML in May 1996 in Germany.

⇨ Information concerning initial activities of the Council's working group on planning and equipping metrological and testing laboratories was given by Dr Issaev. It was noted that OIML publications on verification equipment and planning of laboratories could be reviewed.

⇨ Discussion concerning the evaluation of the OIML symposium on metrological activities took place as most of the delegates to the Council participated in the symposium as well. It was noted that the symposium reviewed metrological policy issues, metrology cooperation and assistance to national metrology services. The presentations and lectures demonstrated that legal metrology was an important part of the economic and industrial development, and that much more is needed in support of the implementation of legal metrology, worldwide harmonization of its requirements and procedures, and the development of means for building mutual confidence among the Members of OIML.

⇨ Guidelines for future activities of the Council were discussed, and it was decided that a work program for 1996–1997 would be prepared taking into account the continuation of the main activities from the previous program and new ones, including:

- identifying the fields of cooperation and assistance based on information of metrological status of OIML developing nations;
- promoting cooperation with national, regional and international institutions concerned with development activities;
- coordinating the Council's working groups on training and planning of metrological and testing laboratories;
- organizing various training courses and seminars in cooperation with other institutions;
- collecting and disseminating information on all subjects regarding development activities in metrology;
- preparing relevant reports for the Tenth International Conference of Legal Metrology in 1996,
- carrying out a survey on a concept of metrological activities in developing countries; and
- using new media for exchanging information on training, e.g. on-line data bases and CD ROM; the Bureau was invited to study, in liaison with the appropriate TCs/SCs and the Development Council, the possibility of making use of such media.

⇨ The Development Council noted that the OIML Certificate System will be of particular value to development provided that legal measuring equipment meets international requirements. The Development Council noted, however, that developing countries will still need to establish basic testing facilities to ensure and maintain the national compatibility of measuring instruments to the international certificate.

⇨ The Council expressed its appreciation of the activities carried out under the leadership of M. Benkirane, President of the Development Council from 1988 to 1995, and a new President was elected for the period 1995–1997: G.M. Putera, CIML Member for Indonesia.

⇨ It was decided that the next meeting of the Development Council would be held in conjunction with the Tenth Conference and the 31st CIML meeting in November 1996 in Vancouver (Canada).

- The Cuban delegation distributed an invitation to delegates of the Council and all interested parties to attend the third international symposium *Metrology '96* to be held in Cuba in October 1996 *(see p. 59)*.

Decisions of the OIML Development Council meeting were endorsed by the 30th CIML meeting.

G. M. Putera, CIML Member for Indonesia will lead the OIML Development Council during the 1995–1997 period after his election as President during the meeting in Beijing, 25 Oct. 1995.

G.M. Putera, Membre du CIML pour l'Indonésie, présidera le Conseil de Développement de l'OIML de 1995 à 1997 suite à son élection pendant la réunion qui s'est tenue à Pékin le 25 octobre 1995.

CONSEIL DE DEVELOPPEMENT

Le Conseil de Développement OIML s'est réuni le 25 octobre 1995 à Pékin, en liaison avec le Symposium OIML sur les *Activités métrologiques dans les pays en développement* et la 30e réunion du CIML.

Présidence: M. Benkirane (Maroc), Président du Conseil de Développement, avec G.J. Faber, Président du CIML, et B. Athané, Directeur du BIML.

Participation: 80 délégués et observateurs de 43 Pays membres et Membres correspondants de l'OIML, représentants d'organisations internationales, régionales et spécialisées: IMEKO, APLMF, WELMEC et DAM. Des rapports pour la réunion ont été reçus de ISO/DEVCO, ORAN et CIMET.

Points principaux

- L'ordre du jour contenait les principaux points suivants:
  - Rapport du BIML sur les activités du Conseil depuis sa dernière réunion en octobre 1994
  - Discussion concernant l'importance du symposium OIML sur les activités métrologiques dans les pays en développement, qui s'est tenu les 23 et 24 octobre 1995
  - Directives pour les futures activités du Conseil, comprenant l'enseignement et la certification
  - Election du Président du Conseil de Développement.

- Un rapport du BIML sur la réalisation du programme de travail en 1994–1995 a été présenté au Conseil. Il a été noté que, suivant le document *Politique à long terme de l'OIML* et la *Brochure d'information générale,* publiés tous deux en 1995, une large priorité a été donnée aux activités de développement. La publication de ces deux documents constitue une aide importante à l'activité métrologique, en démontrant le rôle et les tâches de la coopération métrologique internationale aux autorités gouvernementales et organes nationaux métrologiques dans les pays en développement. Le rapport donnait des informations sur la coopération aux niveaux régional et international, incluant les liaisons de l'OIML avec IMEKO, ISO, ONUDI, APLMF, UN/ECE, ORAN, CIMET et autres organisations.

- Certains cours de formation et séminaires ont été organisés pendant la période 1994–1995 en coopération avec des institutions en liaison:
  - Cours de formation sur *Détermination du volume des réservoirs de stockage fixes* par

PTB/DAM, tenu en juillet 1995 en Allemagne avec la participation de l'OIML. Quelque 20 représentants de pays en développement divers et de pays en transition ont été choisis pour y participer.

- Séminaire de formation *Métrologie au service du développement économique* pour des représentants de pays en transition vers une économie de marché, tenu en mars 1995 à Paris, France, organisé conjointement avec UN/ECE, OIML et des institutions de métrologie françaises. Le séminaire a été suivi par 15 spécialistes. Ont été invités des conférenciers de pays européens, des Etats-Unis d'Amérique, du BIML et d'organisations régionales: WELMEC, EUROMET, EAL.
- Une réunion d'experts sur la qualité, la normalisation et la métrologie, co-sponsorisée par BEST de Rép. Pop. de Chine et l'ONUDI, s'est tenue à Pékin en avril 1995, et un exposé sur les activités OIML a été présenté par le Directeur du BIML.
- Un cours annuel sur la métrologie légale a eu lieu à Cuba en octobre 1995, et plusieurs participants de pays d'Amérique latine ont été sponsorisés par l'Office cubain de Normalisation.

⇨ Des activités du groupe de travail du Conseil sur l'enseignement de la métrologie ont été reprises par le président du groupe, Dr Wallerus, DAM, Allemagne. Un questionnaire a été envoyé aux membres du groupe en vue de recueillir des informations et propositions concernant l'organisation des cours, les échanges d'informations appropriées et de documentation, et l'utilisation de nouveaux moyens électroniques tels que courrier électronique et CD-ROM. Un séminaire international sur le *Contrôle du poids net des preémballés* a été prévu par PTB/DAM, en coopération avec l'OIML, pour mai 1996 en Allemagne.

⇨ Des informations concernant les premières activités du groupe de travail du Conseil sur la planification et l'équipement de laboratoires de métrologie et d'essai ont été données par Dr Issaev. Il a été noté que les publications OIML sur l'équipement de vérification et la planification des laboratoires pourraient être revues.

⇨ Des discussions sur l'estimation du symposium OIML sur les activités métrologiques ont pu avoir lieu car la plupart des délégués du Conseil ont participé aussi au symposium. Il a été noté que le symposium avait revu les questions de politique métrologique, la coopération métrologique et l'aide aux services nationaux de métrologie. Les présentations et exposés ont démontré que la métrologie légale était une part importante du développement économique et industriel, et qu'il est encore plus important de favoriser l'établissement de la métrologie légale, une harmonisation mondiale de ces exigences et procédures et le développement de moyens de créer une confiance mutuelle parmi les Membres de l'OIML.

⇨ Des directives pour les activités futures du Conseil ont été examinées, et il a été décidé que le programme de travail pour 1996–1997 serait préparé en prenant en compte la poursuite des activités principales pour le prochain programme, et des nouvelles actions, en incluant:

- l'identification des domaines de coopération et d'aide basés sur l'information du statut métrologique des pays en développement de l'OIML,
- la promotion de la coopération avec les institutions nationales, régionales et internationales concernées par les activités de développement,
- la coordination des groupes de travail du Conseil sur l'enseignement et l'équipement des laboratoires de métrologie et d'essai,
- l'organisation de divers cours d'enseignement et séminaires en coopération avec d'autres institutions,
- la compilation et la diffusion d'informations sur tous sujets relatifs aux activités du développement en métrologie,
- la préparation de rapports appropriés pour la Dixième Conférence Internationale de Métrologie Légale en 1996,
- la poursuite de l'étude du concept des activités métrologiques dans les pays en développement, et
- l'utilisation des nouveaux moyens pour l'échange d'informations sur l'enseignement, par exemple des bases de données en ligne et des CD-ROM; le Bureau a été prié d'étudier, en liaison avec les TC/SC concernés et le Conseil de Développement, la possibilité d'utiliser de tels moyens.

⇨ Le Conseil de Développement a noté que le Système de Certificats OIML serait d'intérêt particulier au développement, à condition que les équipements de mesure légaux satisfassent aux exigences internationales. Le Conseil de Développement a cependant noté que les pays en développement auraient encore besoin d'établir des équipements d'essai de base pour assurer et maintenir la compatibilité nationale des instruments de mesure aux certificats internationaux.

- Le Conseil a exprimé sa satisfaction en ce qui concerne les activités entreprises sous la direction de M. Benkirane, Président du Conseil de Développement de 1988 à 1995, et un nouveau Président a été élu pour la période 1995-1997: G.M. Putera, Membre du CIML pour l'Indonésie.

- Il a été décidé que la prochaine réunion du Conseil de Développement se tiendrait en conjonction avec la Dixième Conférence et la 31e réunion du CIML, en novembre 1996 à Vancouver (Canada).

- La délégation cubaine a distribué une invitation aux participants du Conseil et à tous les participants intéressés pour assister au 3e symposium international "Métrologie-96" qui se tiendra à Cuba en octobre 1996 *(voir p. 59)*.

Les décisions du Conseil de Développement OIML ont été approuvées par la 30e réunion du CIML.

TC 7/SC 5

Dimensional measuring instruments

Secretariat: Australia

OIML TC 7/SC 5 held a meeting in Paris, 11–12 September 1995.

Chairman: I. Hoerlein, National Standards Commission

Participation: 22 delegates representing 8 P-member and 3 O-member countries; B. Athané, BIML.

Main points

- The first committee draft *Multi-dimensional measuring instruments* was discussed, and in particular the following points:
  - Acceptable units of measurement; dimensional weight
  - Scale interval and test scale interval, if appropriate (definition and value)
  - Minimum dimension and limits of indication
  - Maximum permissible errors
  - Appropriateness of repeatability requirements
  - Difference between indications and rounding of indications
  - Influence quantities, disturbances, humidity
  - Indicators and printing devices
  - Sealing
  - Checking facilities
  - Metrological control

A second committee draft will be prepared by March 1996 and circulated for comment by July 1996 with a possible meeting in September-October 1996.

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TC 7/SC 5

Instruments de mesures dimensionnelles

Secrétariat: Australie

Le sous-comité technique OIML TC 7/SC 5 a tenu une réunion à Paris les 11–12 septembre 1995.

Président: I. Hoerlein, National Standards Commission

Participation: 22 délégués représentant 8 pays membres-P et 3 pays membres-O; B. Athané, BIML.

Points principaux

- Le premier projet de comité *Instruments de mesures multi-dimensionnelles* a été discuté, et en particulier les points suivants:
  - Unités de mesure acceptables; poids dimensionnel
  - Echelon, et échelon d'essai, si approprié (définition et valeur)
  - Dimension minimale et limites d'indication
  - Erreurs maximales tolérées
  - Nécessité d'exigences relatives à la fidélité
  - Différence entre indications et arrondissage des indications
  - Grandeurs d'influence, perturbations, humidité
  - Indicateurs and dispositifs imprimeurs
  - Scellement
  - Dispositifs de contrôle
  - Contrôle métrologique

Un deuxième projet de comité sera préparé pour mars 1996 et sera distribué pour commentaires avant juillet 1996; une réunion pourrait être organisée en sept.-oct.1996 si nécessaire.

TC 9/SC 2

Automatic weighing instruments

Secretariat: United Kingdom

The *Sous-Direction de la Métrologie* hosted a meeting of OIML TC 9/SC 2 which was held 18–20 Sept. 1995 in Paris.

Chairman: Mr I. Dunmill, NWML

Participation: 29 delegates representing 15 P-member and 2 O-member countries; Ph. Degavre, BIML.

Main points

- Automatic road weighbridges; new draft OIML Recommendation

  Eleven countries had comments on the first draft and one of the main objectives of the meeting was to discuss these comments, together with the replies of the secretariat, and to analyze the problems that were encountered in the draft with particular regard to the following: the scope of the new Recommendation, the accuracy classes, the maximum permissible error regimes, and the relationship between the authorized scale interval of the instrument and these error regimes.

- Weighing in motion (WIM): theoretical and practical approaches - The state-of-the-art in WIM

  Mr B. Jacob, French expert from the *Laboratoire Central des Ponts et Chaussées (LCPC)* and Chairman of the COST 323 Management Committee (COST 323 is the European Action "WIM of road vehicles" which is part of the program of a more general European Cooperation in the field of Scientific and Technical research: COST), presented the state-of-the-art in weighing in motion in Europe, in particular the different technical approaches between slow and high speed weighing in motion; he suggested that the scope of the new OIML draft should be restricted to slow speed weigh in motion: only the instruments that measure at slow speed are really weighing axles or vehicles and are susceptible to being used for legal controls.

- The next meeting of TC 9/SC 2 is expected to be held in 1996.

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TC 9/SC 2

Instruments de pesage à fonctionnement automatique

Secrétariat: Royaume-Uni

Sur invitation de la Sous-Direction de la Métrologie, le sous-comité technique TC 9/SC 2 a tenu une réunion à Paris du 18 au 20 septembre 1995.

Président: M. I. Dunmill, NWML

Participation: 29 délégués représentant 15 pays membres-P et 2 pays membres-O; Ph. Degavre, BIML.

Points principaux

- Ponts-bascules routiers à fonctionnement automatique; nouveau projet de Recommandation OIML

  Onze pays avaient des commentaires sur le 1er projet, et l'un des principaux objectifs de la réunion était de discuter ces commentaires et les réponses du secrétariat, et d'analyser les différents problèmes rencontrés à la lecture de ce projet de Recommandation, en particulier sur les suivants: le domaine d'application de la Recommandation, les classes d'exactitude, les régimes d'erreur maximale tolérée et la relation entre les échelons autorisés et ces régimes d'erreur.

- Pesage en marche: approches théoriques et pratiques - L'état de l'art des techniques de pesage en marche

  M. B. Jacob, expert français du Laboratoire Central des Ponts et Chaussées (LCPC) et Président du Comité de Direction de COST 323 (COST 323 est l'Action "Pesage en marche des véhicules routiers" qui fait partie du programme plus général de Coopération européenne dans les domaines de recherche Scientifique et Technique: COST), a présenté l'état de l'art des techniques de pesage en marche en Europe, en particulier les différentes approches techniques du pesage en marche à faible et haute vitesses; il a suggéré que le domaine d'application du nouveau projet OIML soit limité au pesage à faible vitesse: seuls les instruments qui mesurent à faible vitesse pèsent réellement les essieux et les véhicules et sont susceptibles d'être utilisés pour des contrôles légaux.

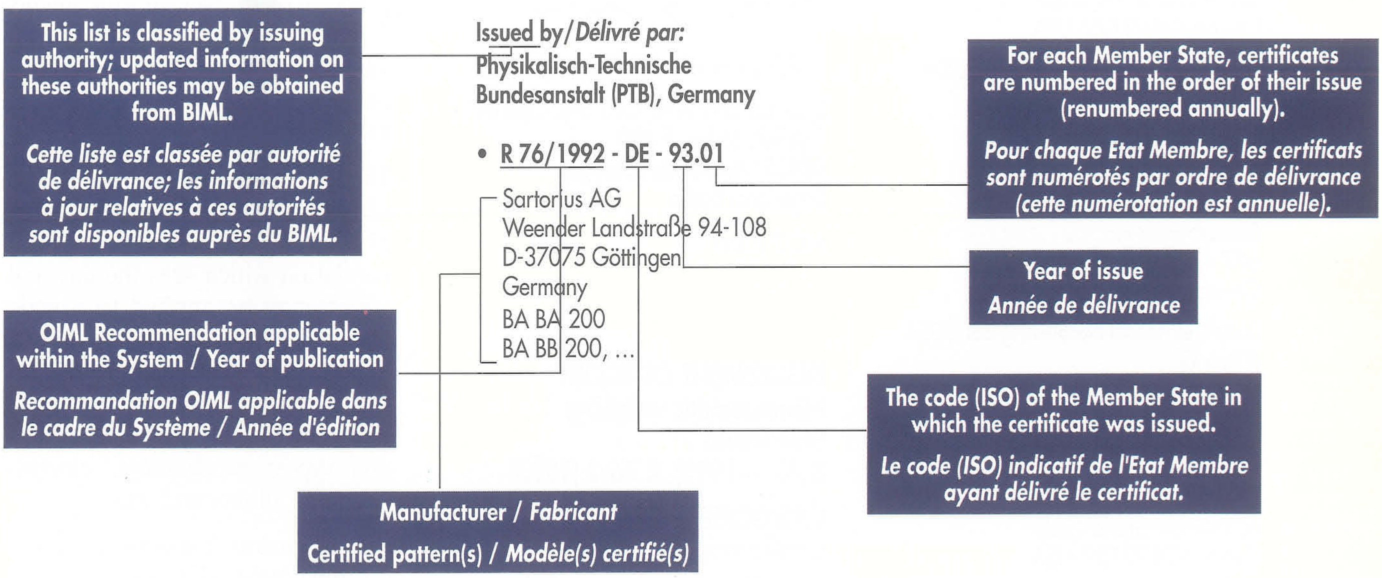
- La prochaine réunion du TC 9/SC 2 est prévue pour 1996.

Contact pour information:
Voir version anglaise à gauche.

OIML certificate system / système de certificats

OIML CERTIFICATES registered from 1995.09 to 1995.11
CERTIFICATS OIML enregistrés de 1995.09 à 1995.11

HOW TO USE THE LIST OF OIML CERTIFICATES
COMMENT UTILISER LA LISTE DES CERTIFICATS OIML



INSTRUMENT CATEGORY Load cells R 60 (1991), Annex A (1993)
CATEGORIE D'INSTRUMENT Cellules de pesée R 60 (1991), Annexe A (1993)

Issued by/Délivré par:

National Weights and Measures Laboratory (NWML), United Kingdom

- **R 60/1991-GB-95.12**

GEC Avery Ltd.
Foundry Lane, Smethwick, Warley
West Midlands, B66 2LP, Great Britain

Load Cell Model No T203 (Class C)

- **R 60/1991-GB-95.13**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Sensortronics 65083C-S (Class C)

- **R 60/1991-GB-95.14**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Sensortronics 65061C (Class C)

- **R 60/1991-GB-95.15**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SSL30A (Class C)

- **R 60/1991-GB-95.16**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SBL 100A (Class C)

• **R 60/1991-GB-95.17**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SBL110 SA (Class C)

• **R 60/1991-GB-95.18**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SBL30A (Class C)

• **R 60/1991-GB-95.19**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SCL20A (Class C)

• **R 60/1991-GB-95.20**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SSL 30SA (Class C)

• **R 60/1991-GB-95.21**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SBL 90A (Class C)

• **R 60/1991-GB-95.22**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SBL30SA (Class C)

• **R 60/1991-GB-95.23**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Shering SCL20SA (Class C)

• **R 60/1991-GB-95.24**

Transdutec S.A.
C/ Joan Miró 11
08930 - Sant Adrià de Besós
Barcelona, Spain

Load Cell Model No Transdutec S.A. TPP-1 (Class C)

• **R 60/1991-GB-95.25**

Sensortronics Inc.
677 Arrow Grand Circle
Covina, CA 91722, USA

Load Cell Model No Veccer VC 5700 (Class C)

Issued by/Délivré par:

Netherlands Measurement Institute (NMi) IJkwezen B.V., The Netherlands

• **R 60/1991-NL-95.14**

Epel Industrial S.A., Ctra. Sta. Cruz de Calafell, 35 km. 9,400
08830 Sant Boi de Llobregat
Barcelona, Spain

MC-2 (Class C)

INSTRUMENT CATEGORY
Nonautomatic weighing instruments
R 76-1 (1992), R 76-2 (1993)

CATEGORIE D'INSTRUMENT
Instruments de pesage à fonctionnement non automatique
R 76-1 (1992), R 76-2 (1993)

Issued by/Délivré par:
Physikalisch-Technische Bundesanstalt (PTB), Germany

• **R 76/1992-DE-95.02**

Sartorius A.G.
Weender Landstraße 94-108
D-37075 Göttingen, Germany

KA BC 100, MB BC 100, BA BC 200, MA BC 200 and MD BC 200 (Classes I and II)

Corrigendum – On page 45 of the previous issue of the OIML Bulletin (Vol. XXXVI, October 1995), the second certificate in the third column under this instrument category should be listed as R 76/1992-DE-94.04 Rev 1.

OIML ACTIVITIES IN THE AREA OF MEASURING SYSTEMS FOR LIQUIDS AND THEIR CERTIFICATION

With the publication of Recommendations R 117 *Measuring systems for liquids other than water* and R 118 *Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles,* and that of Annex C (Test report format) to R 105 *Direct mass flow measuring systems for quantities of liquids,* a very important category of measuring instruments is now covered by recent documents, thereby permitting OIML certification of certain instruments in this category.

The R 117 is not only a compilation of former Recommendations Rs 5, 27, 57, 67 and 77; it is also a new regulation which sees the day and which may be applied to a wide variety of measuring systems for liquids other than water, from gasoline pumps to pipe-line systems, and equipped with meters of various types: mechanical, electromagnetic, ultrasound, etc.

An important innovation is the establishment of accuracy classes with maximum permissible errors ranging from 0.3 % to 2.5 %, depending on the intended use of the instruments. For a given system, the maximum permissible error must be observed for all liquids and at all ordinary flow capacities of the system, which allows one to ensure that for a given liquid and at a normal flow, the real error can be maintained (by an appropriate adjustment) at a significantly lower value than maximum permitted value. Thus, for pipe-line systems, actual errors in the order of 0.1 % and less are entirely feasible, and that responds to the economic needs of the producers as well as to those of the transporters and consumers of petroleum products. The R 118 applies to one of the categories for measuring systems covered by R 117: fuel dispensers or gasoline pumps.

Taking into account the quantity of gasoline pumps manufactured annually throughout the world, their international trade, and the economic value of petroleum products and other fuel measured by these instruments, there was an urgent need for OIML to harmonize the test procedures put into application by national metrology services for the pattern approval of such instruments. It was also urgent that it be possible to apply OIML certification to these instruments in order to contribute to the mutual recognition of their tests and approvals. The R 118 therefore contains not only a description of test procedures, but also the report format for presenting the results of these tests in a harmonized manner.

Other categories of measuring systems other than water could subsequently receive OIML certificates, either through the extension of R 118 to cover such categories, or through the development of specific Recommendations. For direct mass flow measuring systems for quantities of liquids, R 105 (published in 1993) contains metrological requirements and, in Annexes A and B, test procedures; Annex C, now available, provides the test report format which makes it possible for these instruments to be covered by OIML certification. Direct mass flow measuring systems (not to be confused with indirect mass systems which include a volume meter, density and/or temperature cells, and a calculator - and which are covered by R 117) are in demand to occupy an increasingly important place on the market. Their OIML certification will most likely spark off a new demand for their use by harmonizing and accelerating the metrological controls to which they are submitted.

The activity of OIML with regard to measuring systems for liquids doesn't stop here: in the near future, one can expect the publication of OIML Recommendations R 119 and R 120 on pipe provers and measurements of standard capacity measures used for testing these systems, as well as International Document D 25 on vortex meters. As for water meters, the revision of R 49 is making good progress (including the requirements for electronic meters) and may be ready in 1996 or 1997. ■

LES ACTIVITÉS DE L'OIML DANS LE DOMAINE DES ENSEMBLES DE MESURAGE DE LIQUIDES ET LEUR CERTIFICATION

Avec la publication des Recommandations R 117 *Ensembles de mesurage de liquides autres que l'eau*, R118 *Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur*, et de l'Annexe C (Format du rapport d'essai) à la Recommandation R 105 *Ensembles de mesurage massiques directs de quantités de liquides*, c'est une très importante catégorie d'instruments de mesure qui se voit couverte par des textes récents et qui permettent la certification OIML de certains d'entre eux.

La R 117 n'est pas seulement la compilation des anciennes Recommandations R 5, 27, 57, 67 et 77; c'est aussi une réglementation nouvelle qui voit le jour et qui peut s'appliquer à une large variété d'ensembles de mesurage de liquides autres que l'eau, allant des pompes à essence aux ensembles sur pipeline, et munis de compteurs de types variés: mécaniques, électromagnétiques, à ultra-sons, etc.

Une innovation importante est l'établissement de classes d'exactitude, avec des erreurs maximales tolérées allant de 0,3 % à 2,5 %, en fonction de l'utilisation prévue des instruments. Pour un ensemble donné, l'erreur maximale tolérée doit être observée pour tous les liquides et à tous les débits usuels de l'ensemble, ce qui permet d'assurer que, pour un liquide donné et au débit normal, l'erreur réelle peut être maintenue, par un réglage approprié, à une valeur sensiblement plus faible que la valeur maximale tolérée. Ainsi, pour les ensembles sur pipe-line, des erreurs effectives de l'ordre de 0,1 % et moins sont tout à fait réalisables, et cela répond aux besoins économiques tant des producteurs que des transporteurs et consommateurs de produits pétroliers. La R 118 s'applique à une des catégories d'ensembles de mesurage couverts par la R 117: les distributeurs routiers, ou pompes à essence.

Compte tenu de la quantité de pompes à essence construites annuellement à travers le monde, de leur commerce international, et de la valeur économique des produits pétroliers et autres carburants qui sont mesurés par ces instruments, il était urgent que l'OIML harmonise les procédures d'essai mises en oeuvre par les services nationaux de métrologie pour l'approbation de modèle de ces instruments. Il était également urgent que la certification OIML puisse s'y appliquer, pour contribuer à la reconnaissance réciproque des essais et approbations de ces instruments. La R 118 contient donc non seulement une description des procédures d'essai, mais aussi le format du rapport permettant de présenter de façon harmonisée les résultats de ces essais.

D'autres catégories d'ensembles de mesurage de liquides autres que l'eau pourront ultérieurement faire l'objet de certificats OIML, soit par l'extension de la R 118 à ces catégories, soit par le développement de Recommandations spécifiques. Pour les ensembles de mesurage massiques directs de quantités de liquides, la R 105 (publiée en 1993) contient les exigences métrologiques et, en Annexes A et B, les procédures d'essai; l'Annexe C maintenant disponible donne le format du rapport d'essai, permettant ainsi à ces instruments d'être couverts par la certification OIML. Les ensembles de mesurage massiques directs (à ne pas confondre avec les ensembles massiques indirects qui comprennent un compteur de volume, des capteurs de densité et/ou de température, et un calculateur — et qui sont couverts par la R 117) sont appelés à prendre une place de plus en plus importante sur le marché. Leur certification OIML va vraisemblablement donner une nouvelle impulsion à leur utilisation, en harmonisant et accélérant les contrôles métrologiques auxquels ils sont soumis.

L'activité de l'OIML vis-à-vis des ensembles de mesurage de liquides ne s'arrête pas là: prochainement seront publiées les Recommandations R 119 et 120, sur les tubes et mesures de capacité étalons utilisés pour l'essai de ces ensembles, et le Document International D 25 sur les compteurs à effet vortex. En ce qui concerne les compteurs d'eau, la révision de la R 49 est en bonne voie (y compris les exigences pour les compteurs électroniques) et pourrait aboutir en 1996 ou 1997. ■

New Publications / *Nouvelles Publications*

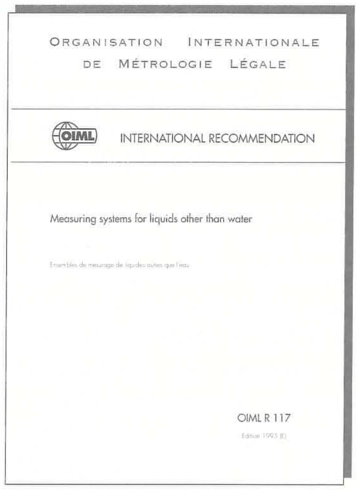
R 105 — Annex C: Test report format
Annexe C: Format du rapport d'essai

R 117 — Measuring systems for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 — Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
Prodédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur

Available in French and English (see OIML Bulletin supplement for price-list).

To order a publication, please contact OIML headquarters:
Bureau International de Métrologie Légale
11, rue Turgot, 75009 Paris, France Fax: 33 1 42 82 17 27



OIML WELCOMES ITS NEW MEMBER

CIML Member
Mr D. Stoichitoiu, Romania

Committee drafts received by BIML

September–November 1995

Stage of development	Title	TC/SC	Secretariat
3 CD	Legal units of measurement	TC 2	Austria
2 CD	Radiochromic film dosimetry system for ionizing radiation processing of materials and products	TC 15	U.S.A.
1 CD	Ergometers for foot crank work; definitions, requirements, tests	TC 18	Germany

liaison activities
OIML
activités de liaison

IMEKO TC 11 Workshop

"Should developing countries invest in a metrological infra-structure?"

A workshop intended to address the question as to whether developing countries should invest in metrological infrastructures was held in Gebze, Turkey, 10–13 Oct. 1995 at the Turkish National Metrology Institute (UME).

Sponsored by the PTB (Germany), the workshop was organized for persons responsible for national measurement standards institutions or for matters of metrology, certification and accreditation in ministries or in other organizations of developing countries or countries in transition. Representatives of the following countries attended the workshop: Albania, Botswana, Burundi, Croatia, Egypt, Estonia, Eritrea, Guatemala, Jordan, Kenya, Madagascar, Malawi, Morocco, Nepal, Nigeria, Peru, Slovenia, Uganda, Vietnam and Zimbabwe.

Given the positive cooperation between OIML development activity and IMEKO TC 11, a BIML representative attended the workshop and gave a lecture on legal metrology and OIML. Important OIML documents such as the *Long-term policy* and *General information brochure* were presented to the participants of the workshop.

Participants had the opportunity to explain the situation of metrology in their countries and discuss their problems with experts and participants from other countries. Draft conclusions concerning the development of a metrological infrastructure were elaborated and discussed by the participants of the workshop.

A technical visit to the UME metrological laboratories was organized during the workshop, permitting a demonstration of the new facilities and the organization of metrological work conducted at this National Metrology Institute. ■

A.V.

Contact information:

(concerning IMEKO TC 11)

E. Seiler
Chairman of IMEKO TC 11
c/o Physikalisch-Technische Bundesanstalt
Postfach 33 45
38023 Braunschweig
Germany

Fax: +49 531 592 8225

(concerning OIML development activities)

Bureau International de Métrologie Légale
11 rue Turgot
75009 Paris
France

Fax: 33 (1) 42 82 17 27

Principal lectures and presentations of the IMEKO workshop

The significance of metrology in today's world
Dr E. Seiler, PTB

Is a national metrology institute indispensable?
Prof. Beyer, PTB

The concept of traceable measurements and the role of calibration services
Dr Ugur, UME

Legal metrology objectives, tasks and mode of operation
Dr A. Vichenkov, BIML

Conformity assessment, ISO 9000, certification, accreditation
Prof. Beyer, PTB

Education and training in metrology
Prof. Bozicevic, University of Zagreb

International metrology organizations and regional cooperation in metrology
Dr E. Seiler, PTB

International, regional and bilateral technical cooperation projects supporting the establishment of metrological infrastructures
Dr Drnovsek, University of Ljubljana

Case studies

Development of the metrological infrastructure in Turkey
Dr Ugur, UME

Metrological infrastructure in small countries
Dr Drnovsek, University of Ljubljana

Asia-Pacific Legal Metrology Forum

The second meeting of the Asia-Pacific Legal Metrology Forum was held in Beijing on 22 Oct. 1995 in association with OIML meetings (the 30th CIML meeting and the OIML Development Council meeting).

The forum meeting was chaired by Dr Gao Jie, Deputy Director, China National Institute of Measurement and Testing, and a member of the International Committee of Weights and Measures (CIPM). The forum was attended by over 50 delegates and observers from forum member economies, as well as representatives of OIML, Asia-Pacific Metrology Program (APMP), Pacific Area Standards Congress (PASC) and the West European Legal Metrology Cooperation (WELMEC) and observers from Mongolia, Romania, Russia and Vietnam.

Arising from the work program established by the first forum meeting in November 1994 the forum considered draft reports of surveys of legislative harmonisation, requirements for prepacked goods and training. The forum noted that legislation has been developed for national requirements. However, mutual recognition agreements may require additional requirements and well defined, harmonised legislation.

In considering the draft survey on requirements for prepacked articles, the forum noted that whilst there are two OIML International Recommendations relating to net contents and information on package labels, there were significant variations between legislative requirements in member economies that could constitute technical barriers to trade. Topics that will receive further consideration include sampling schemes, permitted deficiencies, drained weight and standard sizes.

The forum noted that mutual recognition in the region will require confidence in measurement skills and capability in both legal metrology authorities and the broader measurement community. This would be greatly assisted by harmonised training courses. The forum discussed a proposal by Australia to develop measurement competency standards.

The forum also finalised proposals for regional intercomparisons of mass standard calibration and approved testing of nonautomatic weighing instruments, and supported a proposal for an intercomparison on load cell testing. The forum supported linking intercomparison tests with other regional bodies to promote the principles established on the international level by OIML, and supported WELMEC member involvement in the nonautomatic weighing instrument and load cell intercomparisons.

The forum meeting established new working parties on utility meters and mutual recognition agreements, resolved to conduct a technical infrastructure survey on the needs of legal metrology in the region and agreed to extend forum membership to Mongolia, Russia and Vietnam.

The next meeting of the forum will be held in Vancouver on 3 November 1996 in association with the Tenth International Conference of Legal Metrology. ■

Contact information:

Asia-Pacific Legal Metrology Forum
PO Box 282 North Ryde
New South Wales 2113
Australia

Tel.: (02) 888 3922
Fax: (02) 888 3033

ISO/TAG 4 Meeting

The representatives of the seven international organizations cooperating in the framework of ISO/TAG 4 (BIPM, IEC, ISO, IFCC, IUPAC, IUPAP, and OIML) assembled in Geneva 29–30 Nov. 1995.

The previous meeting of ISO/TAG 4 had been held in June 1993, but this does not mean that TAG 4 was inactive during this whole period: in addition to the publication of the *International vocabulary of basic and general terms in metrology - VIM* (bilingual French-English edition, 1993) and the *Guide to the expression of uncertainty in measurement - GUM* (English editions, 1993 and 1995 and French edition, 1995), the participants of TAG 4 had the task of reflecting on the proposal that had been made 36 months ago to create a forum which would permit global organizations having metrological activities to pursue their cooperation in an inter-organizational framework.

After a positive welcome of the principle of such a proposal by the majority of the organizations concerned, a draft Charter was established during the November 1995 meeting and is now being studied by the steering committees of the seven organizations. The Forum for Inter-organizational Cooperation in Metrology (FICOM) could possibly come into being as of November 1996, on the occasion of a meeting which would begin under the aegis of ISO/TAG 4 before continuing under that of the FICOM.

The inter-organizational cooperation activities of TAG 4 would then fall under the responsibilities of the FICOM, whereas the coordination of the metrological activities of ISO technical committees, also the responsibility of TAG 4, would be undertaken by a specific ISO body (which may be still designated as TAG 4).

Until then, TAG 4 activity will continue with an examination of the remarks formulated with regard to the VIM (in particular by a joint group, ISO TC 12/IEC TC 25) on the concepts of quantities, physical quantities, measurable quantities, etc. A decision to revise the VIM may then be submitted to the FICOM. In that which concerns the GUM, it was agreed that there is no need to revise it, but that the elaboration of secondary guides for applications in various areas was becoming urgent. ■

Réunion ISO/TAG 4

Les représentants des sept organisations internationales qui coopèrent dans le cadre de ISO/TAG 4 (BIPM, CEI, ISO, IFCC, IUPAC, IUPAP, et OIML) se sont retrouvés à Genève les 29 et 30 novembre 1995.

La précédente réunion de ISO/TAG 4 remontait à juin 1993, mais cela ne signifie pas que le TAG 4 avait été inactif pendant toute cette période: outre les publications du *Vocabulaire international des termes fondamentaux et généraux de métrologie, VIM* (édition bilingue, 1993) et du *Guide pour l'expression de l'incertitude de mesure, GUM* (éditions en anglais, 1993 et 1995, et en français, 1995), les participants au TAG 4 ont eu à réfléchir à la proposition qui avait été faite il y a 36 mois de créer un forum permettant aux organisations mondiales ayant des activités métrologiques de poursuivre leur coopération dans un cadre inter-organisationnel.

Après un accueil de principe favorable de la part de la plupart des organisations concernées, un projet de constitution a été établi lors de la réunion de novembre 1995 et est maintenant étudié par les comités directeurs des sept organisations. Le Forum Inter-organisationnel de Coopération en Métrologie, FICOM, pourrait ainsi voir le jour en novembre 1996, à l'occasion d'une réunion qui commencerait sous l'égide de ISO/TAG 4 avant de se poursuivre sous celle du FICOM.

Les activités de coopération inter-organisationnelle du TAG 4 passeraient alors sous la responsabilité du FICOM, tandis que la coordination des activités métrologiques des comités techniques de l'ISO, également de la responsabilité du TAG 4, serait assumée par un organe spécifique à l'ISO (et peut-être toujours désigné TAG 4).

D'ici là, l'activité du TAG 4 va se poursuivre avec un examen de remarques formulées au sujet du VIM (en particulier par un groupe commun ISO TC 12/IEC TC 25) sur les concepts de grandeurs, grandeurs physiques, grandeurs mesurables, etc. Une décision de réviser le VIM pourrait ensuite être soumise au FICOM. En ce qui concerne le GUM, il a été estimé qu'il n'y avait pas lieu de le réviser, mais que l'élaboration de guides secondaires, pour des applications dans divers domaines, devenait urgente. ■

9th WELMEC Committee Meeting

A WELMEC committee meeting was held in Paris, 11–12 Sept. 1995.

As agreed at the previous meeting of the committee, the legal metrology authorities of the countries which have entered an Agreement with the European Union were invited to participate as Observers: Bulgaria, Hungary, Poland, Romania, Slovakia and the Czech Republic. These metrology bodies are invited to become Associate Members of WELMEC. A number of important issues were discussed and are summarized hereafter:

- Extension of the Type Approval Agreement to direct mass flow measuring systems for quantities of liquids (OIML R 105), and fuel dispensers for motor vehicles (OIML R 117 and R 118).

- Cooperation with European organizations on certification and accreditation (EAL and EAC) to identify the relevant quality standards in the EN 45000 series applicable to the EC directives in the field of legal metrology, and to elaborate common guidance on the application of these standards by revising the existing relevant WELMEC publication.

- Continuation of the work for WG 2 *Directive implementation* (EC Directive 93/384) to facilitate all aspects of implementation apart from inspection, enforcement and re-verification.

- Completion of the work of WG 3 *EMeTAS* and establishment of a permanent Steering Group for monitoring the work of the Consortium in charge of this important European data base service.

- Terms of reference for WG 5 *Legal metrology review and enforcement*

- To revise and maintain a Directory of European Legal Metrology and to assist in facilitating any publication of that Directory.

- To maintain a continuous review of legal metrology inspection, verification, and other enforcement related controls in Europe and particularly European member countries of WELMEC.

- To consider enforcement and control issues arising after the placing on the market of weighing and measuring equipment and in connection with the application of regulatory controls in the marketplace.

- To recommend to the WELMEC Committee the issue of agreed advice and guidance in appropriate circumstances and where this might facilitate consistency of interpretation and application of market controls relating particularly to legislation governing the single market.

- To organise such meetings and seminars as may be appropriate to exercise its functions and to liaise with relevant industry and other business and consumer institutions as may be agreed and necessary.

- Follow-up of the working program for WG 6 *Prepackages.* Two major objectives for the WG 6 are (1) writing a guide for prepackaging (to be used for inspections and assessment, and by manufacturers), and (2) writing an interpretation of the directives in order to harmonize the individual interpretations of all member states of the EU.

- WG 7 *Peripherals and PCs* activities. It is suggested to wait for the results of the application of the WELMEC Guide 2.3 on software requirements for non-automatic weighing instruments. As soon as sufficient experience will have been gained, WG 7 is expected to extend Guide 2.3 with a view to the METRO Directive to all categories of measuring instruments.

- WG 8 *Measuring instruments directive.* WG 8 reached an agreement on the question of conformity assessment modules and also worked on the subject of essential requirements. Two possibilities for the essential requirements had been presented by NMi: (1) a very short formulation of objectives in one sentence, or (2) a detailed essential requirements dealing with the qualities which should be required for measuring instruments. The working group in its majority chose the second option and elaborated, from an initial document of NMi, a proposition of essential requirements.

- Inquiry on the present scope of legal metrology in the Member States. As the METRO draft Directive says that each Member State decides at a national level which applications need a certified instrument, it seems necessary to examine what the situation may be after the implementation of this Directive. A questionnaire was elaborated and sent to WELMEC members in order to identify which categories and for which applications the legal control is required, in order to make projections as to the national dispositions which are foreseen for the implementation of the Directive. ■

MOUVEMENT FRANÇAIS POUR LA QUALITÉ

METROLOGIE 95

16–19 Oct. 1995 – Nîmes, France

Rapport sur le Septième Congrès International de Métrologie

16 au 19 octobre 1995 - Nîmes

Métrologie 95 a accueilli cette année 450 personnes dont 80 étudiants (Ecoles des Mines de Douai et d'Alès, Lycée Jules Richard à Paris et IMQ à Toulon) pendant les 3 jours du congrès. La participation au congrès a été en augmentation de 25 % par rapport à 1993.

Les congressistes sont issus, en majorité, de l'industrie et du secteur public (laboratoires et grands groupes). Ils travaillent principalement dans le domaine de la métrologie et de la recherche.

Le succès de *Métrologie 95*, assuré grâce au soutien de nombreux partenaires (Commission des Communautés Européennes, Ministère de l'Industrie, IMGC-CNR, Université Paris VI, industriels) permet de préparer dès aujourd'hui *Métrologie 97,* dont la ville d'accueil sera déterminée dans quelques mois.

Report on the Seventh International Metrology Congress

16–19 October 1995 - Nîmes

Métrologie 95 welcomed 450 people this year, including 80 students (*Ecoles des Mines de Douai et d'Alès, Lycée Jules Richard* in Paris and IMQ in Toulon), during the three-day Congress. Participation in the Congress increased 25 % in comparison with the turnout in 1993.

The delegates were, for the large part, representatives of industry, the public sector (laboratories and big groups), working primarily in the areas of metrology and research.

The success of *Métrologie 95*, due to the support of many partners (Commission of the European Communities, Ministry of Industry, IMGC-CNR, Paris University VI and industries), makes it possible to start preparations as of today for *Métrologie 97* for which the host city will be determined in the months to come.

The basic principles and practice of flow measurement

Five-day course
20–24 May 1996
NEL, United Kingdom

Held annually for the past eighteen years, this course on flow measurement presents subject matter that is continually reviewed to keep it up to date. It is directed towards personnel involved in the design of plants requiring flow monitoring, or in the purchase, application and calibration of flow measuring equipment.

This course is not intended for flow measurement experts, but for the engineer seeking to know how to choose the flowmeter best adapted for his particular needs, and how to get the most out of it when in service.

An important feature of the course will be practical sessions in which course members will participate, using NEL's comprehensive laboratory facilities. Time will be allocated for small informal discussion groups to cover specialised topics and opportunities will be provided for course members to discuss particular flow measurement problems with NEL staff.

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East Kilbride, Glasgow G75 OQU

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GUIDE POUR L'EXPRESSION DE L'INCERTITUDE DE MESURE

L'édition française du *Guide pour l'expression de l'incertitude de mesure* est enfin disponible. Pour mémoire, ce Guide avait été préparé par un groupe de travail interinstitutionnel composé de représentants de plusieurs organismes internationaux dont le BIPM, l'OIML, l'ISO et la CEI.

Les deux versions du guide (anglaise et française) peuvent être obtenues auprès du BIML.

WORKSHOP ON CHECKING THE NET CONTENT OF PREPACKAGES

Munich, 3–10 May, 1996

This workshop will be jointly organized by the *Physikalisch-Technische Bundesanstalt (PTB)*, and the *Deutsche Akademie für Metrologie (DAM)* in co-operation with OIML and sponsored by the *Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)*. The workshop is addressed to participants from developing countries and particularly, employees of a national metrology service and familiar with practical verification work. Full proficiency in English is indispensable since English will be the working language.

Objective

To familiarize verification inspectors with national regulations and international standards; statistical principles, sampling procedures; measurement procedures for the determination of the net content; and the evaluation of the test results.

Documents to be submitted with application

- Curriculum Vitae
- English language certificate (or other evidence of good command of English for applicants of non-English speaking countries only)
- a short report on the actual situation as regards the legal requirements and the metrological control of prepackages
- an endorsement of the applicant's organization/institution

If applicable:
- a copy of the national regulations on prepackages,
- a description of the test equipment.

Applications

(to be sent to the following address before 1 Feb. 1996)

Physikalisch- Technische
Bundesanstalt, Gruppe 8.2
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D-38023 Braunschweig
Federal Republic of Germany

Fax: +49 531 592 8225

METROLOGIA 96
METROLOGY 96

Havana, Cuba October 1996

Metrology events have earned national, regional and international recognition, with participants coming from practically all regions of the world, including most of the countries from the Americas, particularly from Latin America and the Caribbean, European countries such as Germany, Spain and Italy, and Japan, India and China.

METROLOGY'96 will certainly draw the interest of executives, experts, specialists and technical personnel whose work may have a bearing on metrology – national, regional and international metrological agencies, related enterprises, universities, scientific and technological centers, high level education and state and private marketing companies. It aims to provide a forum for exchanging scientific and technical information, show advances made in production and marketing of measuring instruments, and promote regional and international activities by holding parallel meetings of the International Organization of Legal Metrology, the Pan-American Technical Standards Commission and the Interamerican Metrology System.

Sponsored by the International Organization of Legal Metrology, Pan-American Technical Standards Committee, Interamerican Metrology System, the National Standards Interamerican Bureau of the Republic of Cuba, and MACNOR S.A. (a company specialized in technical services in metrology, quality assessment and standardization) and other national, regional and international agencies.

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meetings OIML réunions

February 1996

16 TC 13 PRETORIA
Measuring instruments for acoustics and vibration

19–20 TAG_{cert} PARIS

20–21 Presidential Council PARIS

November 1996

4–8 Tenth International Conference of Legal Metrology VANCOUVER, CANADA
31st CIML meeting
Development Council meeting

ISO

February–March 1996

26–1 ISO TC 43 PRETORIA
Acoustics

June 1996

13–14 ISO TC 30 MILAN
Measurement of fluid flow in closed conduits

IMEKO

September 1996

10–12 TEMPMEKO '96 TORINO
6th International Symposium on Temperature and Thermal Measurements in Industry and Science

October 1996

7–11 15th IMEKO TC 3 International Conference MADRID

info

XIV IMEKO WORLD CONGRESS

New measurements - Challenges and visions
Tampere, Finland
1–6 June 1997

IMEKO has a long tradition as the forum for the advancement of measurement technology. One of the topical trends is the efficient exchange of information between researchers and the commercial world. XIV IMEKO will include several sessions organised jointly with relevant co-sponsors and technical committees. All fields of the IMEKO technical committees will be covered:

- Education and training in measurement and instrumentation (TC 1)
- Photonic measurements (TC 2)
- Measurement of force and mass (TC 3)
- Electrical measurements (TC 4)
- Hardness measurement (TC 5)
- Measurement science (TC 7)
- Traceability in metrology (TC 8)
- Flow measurement (TC 9)
- Technical diagnostics (TC 10)
- Metrological infrastructure (TC 11)
- Temperature and thermal measurements (TC 12)
- Measurements in biology and medicine (TC 13)
- Measurement of geometrical quantities (TC 14)
- Experimental mechanics (TC 15)
- Pressure and vacuum measurement (TC 16)
- Measurement in robotics (TC 17)

as well as:

- Measurements for the pulp and paper industry
- Measurements in telecommunication
- Environmental measurements

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Below are lists of OIML publications classified by subject and number. The following abbreviations are used: International Recommendation (R), International Document (D), vocabulary (V), miscellaneous publication (P). Publications are available in French and English in the form of separate leaflets, unless otherwise indicated. Prices are given in French-francs and do not include postage.

To order publications, please contact the OIML Secretariat by letter or fax:

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On trouvera ci-dessous une liste des publications OIML classées par sujets et par numéros. Les abréviations suivantes sont utilisées: Recommandation Internationale (R), Document International (D), vocabulaire (V) et autre publication (P). Ces publications sont disponibles en français et en anglais sous forme de fascicules séparés sauf indication contraire. Les prix sont donnés en francs-français et ne comprennent pas les frais d'expédition.

Ces publications peuvent être commandées par lettre ou fax au BIML (voir adresse plus haut).

General
Généralités

R 34 (1979–*1974*) 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 42 (1981–*1977*) 50 FRF
Metal stamps for verification officers
Poinçons de métal pour Agents de vérification

D 1 (1975) 50 FRF
Law on metrology
Loi de métrologie

D 2 (in revision - *en cours de révision*)
Legal units of measurement
Unités de mesure légales

D 3 (1979) 60 FRF
Legal qualification of measuring instruments
Qualification légale des instruments de mesurage

D 5 (1982) 60 FRF
Principles for the establishment of hierarchy schemes for measuring instruments
Principes pour l'établissement des schémas de hiérarchie des instruments de mesure

D 9 (1984) 60 FRF
Principles of metrological supervision
Principes de la surveillance métrologique

D 12 (1986) 50 FRF
Fields of use of measuring instruments subject to verification
Domaines d'utilisation des instruments de mesure assujettis à la vérification

D 13 (1986) 50 FRF
Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications
Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications

D 14 (1989) 60 FRF
Training of legal metrology personnel - Qualification - Training programmes
Formation du personnel en métrologie légale - Qualification - Programmes d'étude

D 15 (1986) 80 FRF
Principles of selection of characteristics for the examination of measuring instruments
Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels

D 16 (1986) 80 FRF
Principles of assurance of metrological control
Principes d'assurance du contrôle métrologique

D 19 (1988) 80 FRF
Pattern evaluation and pattern approval
Essai de modèle et approbation de modèle

D 20 (1988) 80 FRF
Initial and subsequent verification of measuring instruments and processes
Vérifications primitive et ultérieure des instruments et processus de mesure

V 1 (1978) 100 FRF
Vocabulary of legal metrology (bilingual French-English)
Vocabulaire de métrologie légale (bilingue français-anglais)

V 2 (1993) 200 FRF
International vocabulary of basic and general terms in metrology (bilingual French-English)
Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français- anglais)

P 1 (1991) 60 FRF
OIML Certificate System for Measuring Instruments
Système de Certificats OIML pour les Instruments de Mesure

P 2 (1987) 100 FRF
Metrology training - Synthesis and bibliography (bilingual French-English)
Formation en métrologie - Synthèse et bibliographie (bilingue français-anglais)

P 3 (being printed - *en cours de publication)*
Metrology in Member States and Corresponding Member Countries
Métrologie dans les Etats Membres et Pays Membres Correspondants de l'OIML

P 9 (1992) 100 FRF
Guidelines for the establishment of simplified metrology regulations

P 17 (1995) 300 FRF
Guide to the expression of uncertainty in measurement
Guide pour l'expression de l'incertitude de mesure

Measurement standards and verification equipment
Étalons et équipement de vérification

D 6 (1983) 60 FRF
Documentation for measurement standards and calibration devices
Documentation pour les étalons et les dispositifs d'étalonnage

D 8 (1984) 60 FRF
Principles concerning choice, official recognition, use and conservation of measurement standards
Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons

D 10 (1984) 50 FRF
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories
Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais

D 18 (1987) 50 FRF
General principles of the use of certified reference materials in measurements
Principes généraux d'utilisation des matériaux de référence certifiés dans les mesurages

D 23 (1993) 80 FRF
Principles of metrological control of equipment used for verification
Principes du contrôle métrologique des équipements utilisés pour la vérification

P 4 (1986-*1981)* 100 FRF
Verification equipment for National Metrology Services
Equipement d'un Service national de métrologie

P 6 (1987) 100 FRF
Suppliers of verification equipment (bilingual French-English)
Fournisseurs d'équipement de vérification (bilingue français-anglais)

P 7 (1989) 100 FRF
Planning of metrology and testing laboratories
Planification de laboratoires de métrologie et d'essais

P 15 (1989) 100 FRF
Guide to calibration

Mass and density
Masses et masses volumiques

R 15 (1974-*1970)* 80 FRF
Instruments for measuring the hectolitre mass of cereals
Instruments de mesure de la masse à l'hectolitre des céréales

R 22 (1975) 150 FRF
International alcoholometric tables (trilingual French-English-Spanish version)
Tables alcoométriques internationales (version trilingue français-anglais-espagnol)

R 33 (1979-*1973)* 50 FRF
Conventional value of the result of weighing in air
Valeur conventionnelle du résultat des pesées dans l'air

R 44 (1985) 50 FRF
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
Alcoomètres et aréomètres pour alcool et thermomètres utilises en alcoométrie

R 47 (1979-*1978)* 60 FRF
Standard weights for testing of high capacity weighing machines
Poids étalons pour le contrôle des instruments de pesage de portée élevée

R 50 (1994) 100 FRF
Continuous totalizing automatic weighing instruments
Instruments de pesage totalisateurs continus à fonctionnement automatique

R 51 (being printed - *en cours de publication)*
Automatic catchweighing instruments
Instruments trieurs-étiqueteurs à fonctionnement automatique

R 52 (1980) 50 FRF
Hexagonal weights, ordinary accuracy class from 100 g to 50 kg
Poids hexagonaux de classe de précision ordinaire, de 100 g à 50 kg

R 60 (1991) 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée

Annex (1993) 80 FRF
Test report format for the evaluation of load cells
Format du rapport d'essai des cellules de pesée

R 61 (being printed - *en cours de publication*)
Automatic gravimetric filling instruments
Doseuses pondérales à fonctionnement automatique

R 74 (1993) 80 FRF
Electronic weighing instruments
Instruments de pesage électroniques

R 76-1 (1992) 300 FRF
Nonautomatic weighing instruments Part 1: Metrological and technical requirements - Tests
Instruments de pesage à fonctionnement non automatique Partie 1: Exigences métrologiques et techniques - Essais

Amendment No. 1 (1994) free / *gratuit*

R 76-2 (1993) 200 FRF
Nonautomatic weighing instruments Part 2: Pattern evaluation report
Instruments de pesage à fonctionnement non automatique Partie 2: Rapport d'essai de modèle

Amendment No. 1 (1995) free / *gratuit*

R 106 (1993) 100 FRF
Automatic rail-weighbridges
Ponts-bascules ferroviaires à fonctionnement automatique

Annex (being printed - *en cours de publication*)
Test procedures and test report format
Procédures d'essai et format du rapport d'essai

R 107 (1993) 100 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie)

Annex (being printed - *en cours de publication*)
Test procedures and test report format
Procédures d'essai et format du rapport d'essai

R 111 (1994) 80 FRF
Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3

P 5 (1992) 100 FRF
Mobile equipment for the verification of road weigh-bridges (bilingual French-English)
Equipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

P 8 (1987) 100 FRF
Density measurement
Mesure de la masse volumique

Length and speed
Longueurs et vitesses

R 21 (1975-*1973*) 60 FRF
Taximeters
Taximètres

R 24 (1975-*1973*) 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour Agents de vérification

R 30 (1981) 60 FRF
End standards of length (gauge blocks)
Mesures de longueur à bouts plans (cales étalons)

R 35 (1985) 80 FRF
Material measures of length for general use
Mesures matérialisées de longueur pour usages généraux

R 55 (1981) 50 FRF
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique

R 66 (1985) 60 FRF
Length measuring instruments
Instruments mesureurs de longueurs

R 91 (1990) 60 FRF
Radar equipment for the measurement of the speed of vehicles
Cinémomètres radar pour la mesure de la vitesse des véhicules

R 98 (1991) 60 FRF
High-precision line measures of length
Mesures matérialisées de longueur à traits de haute précision

Liquid measurement
Mesurage des liquides

R 4 (1972-*1970*) 50 FRF
Volumetric flasks (one mark) in glass
Fioles jaugées à un trait en verre

R 29 (1979-*1973*) 50 FRF
Capacity serving measures
Mesures de capacité de service

R 40 (1981-*1977*) 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour Agents de vérification

R 41 (1981-*1977*) 60 FRF
Standard burettes for verification officers
Burettes étalons pour Agents de vérification

R 43 (1981-*1977*) 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour Agents de vérification

R 45 (1980-*1977*) 50 FRF
Casks and barrels
Tonneaux et futailles

R 49 (in revision - *en cours de révision)*
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 63 (1994) 50 FRF
Petroleum measurement tables
Tables de mesure du pétrole

R 71 (1985) 80 FRF
Fixed storage tanks. General requirements
Réservoirs de stockage fixes. Prescriptions générales

R 72 (1985) 60 FRF
Hot water meters
Compteurs d'eau destinés au mesurage de l'eau chaude

R 80 (1989) 100 FRF
Road and rail tankers
Camions et wagons-citernes

R 81 (1989) 80 FRF
Measuring devices and measuring systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)
Dispositifs et systèmes de mesure de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)

R 85 (1989) 80 FRF
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 86 (1989) 50 FRF
Drum meters for alcohol and their supplementary devices
Compteurs à tambour pour alcool et leurs dispositifs complémentaires

R 95 (1990) 60 FRF
Ships' tanks - General requirements
Bateaux-citernes - Prescriptions générales

R 96 (1990) 50 FRF
Measuring container bottles
Bouteilles récipients-mesures

R 105 (1993) 100 FRF
Direct mass flow measuring systems for quantities of liquids
Ensembles de mesurage massiques directs de quantités de liquides

Annex (1995) 80 FRF
Test report format
Format du rapport d'essai

R 117 (1995) 400 FRF
Measuring systems for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 (1995) 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur

R 119 (being printed - *en cours de publication)*
Pipe provers for testing of measuring systems for liquids other than water
Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 120 (being printed - *en cours de publication)*
Standard capacity measures for testing of measuring systems for liquids other than water
Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

D 4 (1981) 50 FRF
Installation and storage conditions for cold water meters
Conditions d'installation et de stockage des compteurs d'eau froide

D 7 (1984) 80 FRF
The evaluation of flow standards and facilities used for testing water meters
Evaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

D 25 (being printed - *en cours de publication)*
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 (being printed - *en cours de publication)*
Glass delivery measures – Automatic pipettes
Mesures en verre à délivrer – Pipettes automatiques

Gas measurement
Mesurage des gaz(*)

R 6 (1989) 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 31 (1995) 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

Pressure
Pressions(**)

R 23 (1975-*1973)* 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

(*) See also "Liquid measurement" D 25 – *Voir aussi "Mesurage des liquides" D 25.*

(**) See also "Medical instruments" - *Voir aussi "Instruments médicaux".*

R 53 (1982) 60 FRF
Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods
Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination

R 97 (1990) 60 FRF
Barometers
Baromètres

R 101 (1991) 80 FRF
Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)
Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 109 (1993) 60 FRF
Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) 80 FRF
Pressure balances
Manomètres à piston

Temperature
Températures(*)

R 18 (1989) 60 FRF
Visual disappearing filament pyrometers
Pyromètres optiques à filament disparaissant

R 48 (1980–*1978*) 50 FRF
Tungsten ribbon lamps for calibration of optical pyrometers
Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques

R 75 (1988) 60 FRF
Heat meters
Compteurs d'énergie thermique

R 84 (1989) 60 FRF
Resistance-thermometer sensors made of platinum, copper or nickel (for industrial and commercial use)
Capteurs à résistance thermométrique de platine, de cuivre ou de nickel (à usages techniques et commerciaux)

D 24 (being printed - *en cours de publication*)
Total radiation pyrometers
Pyromètres à radiation totale

P 16 (1991) 100 FRF
Guide to practical temperature measurements

(*) See also "Medical instruments" - *Voir aussi "Instruments médicaux".*

Electricity
Électricité

R 46 (1980–*1978*) 80 FRF
Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

D 11 (1994) 80 FRF
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

Acoustics and vibration
Accoustique et vibrations(*)

R 58 (1984) 50 FRF
Sound level meters
Sonomètres

R 88 (1989) 50 FRF
Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

R 102 (1992) 50 FRF
Sound calibrators
Calibreurs acoustiques

Annex (1995) 80 FRF
Test methods for pattern evaluation and test report format
Méthodes d'essai de modèle et format du rapport d'essai

R 103 (1992) 60 FRF
Measuring instrumentation for human response to vibration
Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) 60 FRF
Pure-tone audiometers
Audiomètres à sons purs

Annex (being printed - *en cours de publication*)
Test report format
Format du rapport d'essai

Environment
Environnement

R 82 (1989) 80 FRF
Gas chromatographs for measuring pollution from pesticides and other toxic substances
Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) 80 FRF
Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water
Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 99 (1991) 100 FRF
Instruments for measuring vehicle exhaust emissions
Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) 80 FRF

Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 112 (1994) 80 FRF

High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) 80 FRF

Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux

R 116 (1995) 80 FRF

Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau

R 123 (being printed - *en cours de publication*)

Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux

D 22 (1991) 80 FRF

Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes
Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux

Physico-chemical measurements
Mesures physico-chimiques

R 14 (1995) 60 FRF

Polarimetric saccharimeters
Saccharimètres polarimétriques

R 54 (in revision - *en cours de révision*)

pH scale for aqueous solutions
Echelle de pH des solutions aqueuses

R 56 (1981) 50 FRF

Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 59 (1984) 80 FRF

Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 68 (1985) 50 FRF

Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) 50 FRF

Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) 50 FRF

Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 73 (1985) 50 FRF

Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 92 (1989) 60 FRF

Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 108 (1993) 60 FRF

Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 121 (being printed - *en cours de publication*)

The scale of relative humidity of air certified against satured salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

D 17 (1987) 50 FRF

Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

Medical instruments
Instruments médicaux

R 7 (1979–*1978*) 60 FRF

Clinical thermometers, mercury-in-glass with maximum device
Thermomètres médicaux à mercure, en verre, avec dispositif à maximum

R 16 (1973–*1970*) 50 FRF

Manometers for instruments for measuring blood pressure (sphygmomanometers)
Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)

R 26 (1978–*1973*) 50 FRF

Medical syringes
Seringues médicales

R 78 (1989) 50 FRF

Westergren tubes for measurement of erythrocyte sedimentation rate
Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies

R 89 (1990) 80 FRF
Electroencephalographs - Metrological characteristics - Methods and equipment for verification
Electroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 90 (1990) 80 FRF
Electrocardiographs - Metrological characteristics - Methods and equipment for verification
Electrocardiographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 93 (1990) 60 FRF
Focimeters
Frontofocomètres

R 114 (1995) 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 122 (being printed - *en cours de publication)*
Equipement for speech audiometry
Appareils pour l'audiométrie vocale

D 21 (1990) 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

Testing of materials
Essais des matériaux

R 9 (1972-*1970)* 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974-*1970)* 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974-*1970)* 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974-*1970)* 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 36 (1980-*1977)* 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981-*1977)* 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981-*1977)* 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981-*1977)* 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T - C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T -C,A,N)

R 62 (1985) 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 64 (1985) 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

V 3 (1991) 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

P 10 (1981) 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) 100 FRF
Factors influencing hardness measurement

P 12 (1984) 100 FRF
Hardness test blocks and indenters

P 13 (1989) 100 FRF
Hardness standard equipment

P 14 (1991) 100 FRF
The unification of hardness measurement

Prepackaging
Préemballages

R 79 (1989) 50 FRF
Information on package labels
Etiquetage des préemballages

R 87 (1989) 50 FRF
Net content in packages
Contenu net des préemballages

INTERNATIONAL RECOMMENDATIONS
RECOMMANDATIONS INTERNATIONALES

R 4 (1970–1972) 50 FRF
Volumetric flasks (one mark) in glass
Fioles jaugées à un trait en verre

R 6 (1989) 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 7 (1979–1978) 60 FRF
Clinical thermometers, mercury in-glass with maximum device
Thermomètres médicaux à mercure, en verre, avec dispositif à maximum

R 9 (1972–1970) 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974–1970) 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974–1970) 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974–1970) 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 14 (1995) 60 FRF
Polarimetric saccharimeters
Saccharimètres polarimétriques

R 15 (1974–1970) 80 FRF
Instruments for measuring the hectolitre mass of cereals
Instruments de mesure de la masse à l'hectolitre des céréales

R 16 (1973–1970) 50 FRF
Manometers for instruments for measuring blood pressure (sphygmomanometers)
Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)

R 18 (1989) 60 FRF
Visual disappearing filament pyrometers
Pyromètres optiques à filament disparaissant

R 21 (1975–1973) 60 FRF
Taximeters
Taximètres

R 22 (1975–1973) 150 FRF
International alcoholometric tables (trilingual French-English-Spanish)
Tables alcoométriques internationales (trilingue français-anglais-espagnol)

R 23 (1975–1973) 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

R 24 (1975–1973) 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour agents de vérification

R 26 (1978–1973) 50 FRF
Medical syringes
Seringues médicales

R 29 (1979–1973) 50 FRF
Capacity serving measures
Mesures de capacité de service

R 30 (1981) 60 FRF
End standards of length (gauge blocks)
Mesures de longueur à bouts plans (cales étalons)

R 31 (1995) 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

R 33 (1979–1973) 50 FRF
Conventional value of the result of weighing in air
Valeur conventionnelle du résultat des pesées dans l'air

R 34 (1979–1974) 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 35 (1985) 80 FRF
Material measures of length for general use
Mesures matérialisées de longueur pour usages généraux

R 36 (1980–1977) 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981–1977) 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981–1977) 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981–1977) 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T-C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T-C,A,N)

R 40 (1981–1977) 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour agents de vérification

R 41 (1981–1977) 60 FRF
Standard burettes for verification officers
Burettes étalons pour agents de vérification

R 42 (1981–1977) 50 FRF
Metal stamps for verification officers
Poinçons de métal pour agents de vérification

R 43 (1981–1977) 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour agents de vérification

R 44 (1985) 50 FRF
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
Alcoomètres et aréomètres pour alcool et thermomètres utilisés en alcoométrie

R 45 (1980–1977) 50 FRF
Casks and barrels
Tonneaux et futailles

R 46 (1980–1978) 80 FRF
Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

R 47 (1979–1978) 60 FRF
Standard weights for testing of high capacity weighing machines
Poids étalons pour le contrôle des instruments de pesage de portée élevée

R 48 (1980–1978) 50 FRF
Tungsten ribbon lamps for calibration of optical pyrometers
Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques

R 49 (in revision - *en cours de révision*)
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 50 (1994) 100 FRF
Continuous totalizing automatic weighing instruments (belt weighers)
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande)

R 51 (being printed - *en cours de publication*)
Automatic catchweighing instruments
Instruments trieurs-étiqueteurs à fonctionnement automatique

R 52 (1980) 50 FRF
Hexagonal weights, ordinary accuracy class from 100 g to 50 kg
Poids hexagonaux de classe de précision ordinaire, de 100 g à 50 kg

R 53 (1982) 60 FRF
Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods
Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination

R 54 (in revision - *en cours de révision*)
pH scale for aqueous solutions
Echelle de pH des solutions aqueuses

R 55 (1981) 50 FRF
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique

R 56 (1981) 50 FRF
Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 58 (1984) 50 FRF
Sound level meters
Sonomètres

R 59 (1984) 80 FRF
Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 60 (1991) 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée

Annex (1993) 80 FRF
Test report format for the evaluation of load cells
Format du rapport d'essai des cellules de pesée

R 61 (being printed - *en cours de publication*)
Automatic gravimetric filling instruments
Doseuses pondérales à fonctionnement automatique

R 62 (1985) 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 63 (1994) 50 FRF
Petroleum measurement tables
Tables de mesure du pétrole

R 64 (1985) 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

R 66 (1985) 60 FRF
Length measuring instruments
Instruments mesureurs de longueurs

R 68 (1985) 50 FRF
Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) 50 FRF
Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) 50 FRF
Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 71 (1985) 80 FRF
Fixed storage tanks. General requirements
Réservoirs de stockage fixes. Prescriptions générales

R 72 (1985) 60 FRF
Hot water meters
Compteurs d'eau destinés au mesurage de l'eau chaude

R 73 (1985) 50 FRF
Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 74 (1993) 80 FRF
Electronic weighing instruments
Instruments de pesage électroniques

R 75 (1988) 60 FRF
Heat meters
Compteurs d'énergie thermique

R 76-1 (1992) 300 FRF
Nonautomatic weighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage à fonctionnement non automatique. Partie 1: Exigences métrologiques et techniques - Essais
Amendment No. 1 (1994) free / *gratuit*

R 76-2 (1993) 200 FRF
Nonautomatic weighing instruments. Part 2: Pattern evaluation report
Instruments de pesage à fonctionnement non automatique. Partie 2: Rapport d'essai de modèle
Amendment No. 1 (1995) free / *gratuit*

R 78 (1989) 50 FRF
Westergren tubes for measurement of erythrocyte sedimentation rate
Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies

R 79 (1989) 50 FRF
Information on package labels
Etiquetage des préemballages

R 80 (1989) 100 FRF
Road and rail tankers
Camions et wagons-citernes

R 81 (1989) 80 FRF
Measuring devices and measuring systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)
Dispositifs et systèmes de mesure de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)

R 82 (1989) 80 FRF
Gas chromatographs for measuring pollution from pesticides and other toxic substances
Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) 80 FRF
Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water
Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 84 (1989) 60 FRF
Resistance-thermometer sensors made of platinum, copper or nickel (for industrial and commercial use)
Capteurs à résistance thermométrique de platine, de cuivre ou de nickel (à usages techniques et commerciaux)

R 85 (1989) 80 FRF
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 86 (1989) 50 FRF
Drum meters for alcohol and their supplementary devices
Compteurs à tambour pour alcool et leurs dispositifs complémentaires

R 87 (1989) 50 FRF
Net content in packages
Contenu net des préemballages

R 88 (1989) 50 FRF
Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

R 89 (1990) 80 FRF
Electroencephalographs - Metrological characteristics - Methods and equipment for verification
Electroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 90 (1990) 80 FRF
Electrocardiographs - Metrological characteristics - Methods and equipment for verification
Electrocardiographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 91 (1990) 60 FRF
Radar equipment for the measurement of the speed of vehicles
Cinémomètres radar pour la mesure de la vitesse des véhicules

R 92 (1989) 60 FRF
Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 93 (1990) 60 FRF
Focimeters
Frontofocomètres

R 95 (1990) 60 FRF
Ships' tanks - General requirements
Bateaux-citernes - Prescriptions générales

R 96 (1990) 50 FRF
Measuring container bottles
Bouteilles récipients-mesures

R 97 (1990) 60 FRF
Barometers
Baromètres

R 98 (1991) 60 FRF
High-precision line measures of length
Mesures matérialisées de longueur à traits de haute précision

R 99 (1991) 100 FRF
Instruments for measuring vehicle exhaust emissions
Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) 80 FRF
Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 101 (1991) 80 FRF
Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)
Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 102 (1992) 50 FRF
Sound calibrators
Calibreurs acoustiques

Annex (1995) 80 FRF
Test methods for pattern evaluation and test report format
Méthodes d'essai de modèle et format du rapport d'essai

R 103 (1992) 60 FRF
Measuring instrumentation for human response to vibration
Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) 60 FRF
Pure-tone audiometers
Audiomètres à sons purs

Annex (being printed - *en cours de publication*)
Test report format
Format du rapport d'essai

R 105 (1993) 100 FRF
Direct mass flow measuring systems for quantities of liquids
Ensembles de mesurage massiques directs de quantités de liquides

Annex (1995) 80 FRF
Test report format
Format du rapport d'essai

R 106 (1993) 100 FRF
Automatic rail-weighbridges
Ponts-bascules ferroviaires à fonctionnement automatique

Annex (being printed - *en cours de publication*)
Test procedures and test report format
Procédures d'essai et format du rapport d'essai

R 107 (1993) 100 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie)

Annex (being printed - *en cours de publication*)
Test procedures and test report format
Procédures d'essai et format du rapport d'essai

R 108 (1993) 60 FRF
Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 109 (1993) 60 FRF
Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) 80 FRF
Pressure balances
Manomètres à piston

R 111 (1994) 80 FRF
Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3

R 112 (1994) 80 FRF
High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) 80 FRF
Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux

R 114 (1995) 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 116 (1995) 80 FRF
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau

R 117 (1995) 400 FRF
Measuring systems for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 (1995) 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur

R 119 (being printed - *en cours de publication*)
Pipe provers for testing of measuring systems for liquids other than water
Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 120 (being printed - *en cours de publication*)
Standard capacity measures for testing of measuring systems for liquids other than water
Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 121 (being printed - *en cours de publication*)
The scale of relative humidity of air certified against saturated salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

R 122 (being printed - *en cours de publication*)
Equipment for speech audiometry
Appareils pour l'audiométrie vocale

R 123 (being printed - *en cours de publication*)
Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux

INTERNATIONAL DOCUMENTS
DOCUMENTS INTERNATIONAUX

D 1 (1975) 50 FRF
Law on metrology
Loi de métrologie

D 2 (in revision - *en cours de révision*)
Legal units of measurement
Unités de mesure légales

D 3 (1979) 60 FRF
Legal qualification of measuring instruments
Qualification légale des instruments de mesurage

D 4 (1981) 50 FRF
Installation and storage conditions for cold water meters
Conditions d'installation et de stockage des compteurs d'eau froide

D 5 (1982) 60 FRF
Principles for the establishment of hierarchy schemes for measuring instruments
Principes pour l'établissement des schémas de hiérarchie des instruments de mesure

D 6 (1983) 60 FRF
Documentation for measurement standards and calibration devices
Documentation pour les étalons et les dispositifs d'étalonnage

D 7 (1984) 80 FRF
The evaluation of flow standards and facilities used for testing water meters
Evaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

D 8 (1984) 60 FRF
Principles concerning choice, official recognition, use and conservation of measurement standards
Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons

D 9 (1984) 60 FRF
Principles of metrological supervision
Principes de la surveillance métrologique

D 10 (1984) 50 FRF
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories
Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais

D 11 (1994) 80 FRF
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

D 12 (1986) 50 FRF
Fields of use of measuring instruments subject to verification
Domaines d'utilisation des instruments de mesure assujettis à la vérification

D 13 (1986) 50 FRF
Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications
Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications

D 14 (1989) 60 FRF
Training of legal metrology personnel - Qualification - Training programmes
Formation du personnel en métrologie légale - Qualification - Programmes d'étude

D 15 (1986) 80 FRF
Principles of selection of characteristics for the examination of measuring instruments
Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels

D 16 (1986) 80 FRF
Principles of assurance of metrological control
Principes d'assurance du contrôle métrologique

D 17 (1987) 50 FRF
Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

D 18 (1987) 50 FRF
General principles of the use of certified reference materials in measurements
Principes généraux d'utilisation des matériaux de référence certifiés dans les mesurages

D 19 (1988) 80 FRF
Pattern evaluation and pattern approval
Essai de modèle et approbation de modèle

D 20 (1988) 80 FRF
Initial and subsequent verification of measuring instruments and processes
Vérifications primitive et ultérieure des instruments et processus de mesure

D 21 (1990) 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

D 22 (1991) 80 FRF
Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes
Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux

D 23 (1993) 80 FRF
Principles of metrological control of equipment used for verification
Principes du contrôle métrologique des équipements utilisés pour la vérification

D 24 (being printed - *en cours de publication*)
Total radiation pyrometers
Pyromètres à radiation totale

D 25 (being printed - *en cours de publication*)
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 (being printed - *en cours de publication*)
Glass delivery measures - Automatic pipettes
Mesures en verre à délivrer - Pipettes automatiques

VOCABULARIES
VOCABULAIRES

V 1 (1978) 100 FRF
Vocabulary of legal metrology (bilingual French-English)
Vocabulaire de métrologie légale (bilingue français-anglais)

V 2 (1993) 200 FRF
International vocabulary of basic and general terms in metrology (bilingual French-English)
Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français-anglais)

V 3 (1991) 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

OTHER PUBLICATIONS
AUTRES PUBLICATIONS

P 1 (1991) 60 FRF
OIML Certificate System for Measuring Instruments
Système de Certificats OIML pour les Instruments de Mesure

P 2 (1987) 100 FRF
Metrology training - Synthesis and bibliography (bilingual French-English)
Formation en métrologie - Synthèse et bibliographie (bilingue français-anglais)

P 3 (being printed - *en cours de publication*)
Metrology in OIML Member States and Corresponding Member Countries
Métrologie dans les Etats Membres et Pays Membres Correspondants de l'OIML

P 4 (1986-1981) 100 FRF
Verification equipment for National Metrology Services
Equipement d'un Service national de métrologie

P 5 (1992) 100 FRF
Mobile equipment for the verification of road weighbridges (bilingual French- English)
Equipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

P 6 (1987) 100 FRF
Suppliers of verification equipment (bilingual French-English)
Fournisseurs d'équipement de vérification (bilingue français-anglais)

P 7 (1989) 100 FRF
Planning of metrology and testing laboratories
Planification de laboratoires de métrologie et d'essais

P 8 (1987) 100 FRF
Density measurement
Mesure de la masse volumique

P 9 (1992) 100 FRF
Guidelines for the establishment of simplified metrology regulations

P 10 (1981) 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) 100 FRF
Factors influencing hardness measurement

P 12 (1984) 100 FRF
Hardness test blocks and indenters

P 13 (1989) 100 FRF
Hardness standard equipment

P 14 (1991) 100 FRF
The unification of hardness measurement

P 15 (1989) 100 FRF
Guide to calibration

P 16 (1991) 100 FRF
Guide to practical temperature measurements

P 17 (1995) 300 FRF
Guide to the expression of uncertainty in measurement
Guide pour l'expression de l'incertitude de mesure

OIML BULLETIN

Call For Papers

The Editors of the OIML Bulletin welcome the submission of technical papers and articles that address new advances in metrology, particularly in the fields of trade, health, environment, and safety in which the credibility of measurements remains a challenging priority.

Metrology is adapting to the changes that are rapidly occuring worldwide and the OIML Bulletin strives to reflect this adaptation. National, regional, and international activities concerning evaluation procedures, accreditation and certification, measuring techniques and instrumentation, and implementation of OIML Recommendations as well as other international publications relative to metrology are of interest to the expanding audience of the OIML Bulletin.

In addition to a manuscript and visual materials (photos, illustrations, slides, etc.), a disk copy of the submission should be included whenever possible. Authors are also encouraged to send a passport-size photo for publication. Selected papers will be remunerated at the rate of 150 FRF per printed page, provided that they have not been previously published. The Editors of the OIML Bulletin reserve the right to edit contributions for style and space restrictions.

Papers should be sent to the *Bureau International de Métrologie Légale,* Attn. Editors of the OIML Bulletin, 11, rue Turgot, 75009 Paris France.